Faculty of Social Sciences
University of Helsinki

THE EDUCATIONAL CONSEQUENCES OF ADOLESCENT HEALTH PROBLEMS

Janne Mikkonen

DOCTORAL DISSERTATION

To be presented for public discussion with the permission of the Faculty of Social Sciences of the University of Helsinki, in Festive Hall, Language Center, on the 14th of June, 2021 at 12 o'clock.

Helsinki 2021

Publications of the Faculty of Social Sciences 188
Doctoral Program in Social Sciences
Sociology/Demography

Supervisors
Professor Pekka Martikainen, University of Helsinki
Dr. Heta Moustgaard, University of Helsinki
Dr. Hanna Remes, University of Helsinki

Pre-examiners
Associate Professor Steven A. Haas, Pennsylvania State University
Professor Juho Härkönen, European University Institute

Opponent
Assistant Professor Elina Kilpi-Jakonen, University of Turku

Custos
Professor Pekka Martikainen, University of Helsinki

The Faculty of Social Sciences uses the Urkund system (plagiarism recognition) to examine all doctoral dissertations.

Cover photo:
Teuvo Kanerva / Museovirasto, Historian kuvakokoelma (CC BY 4.0)

Distribution and Sales:
Unigrafia Bookstore
https://shop.unigrafia.fi/

ISSN 2343-273X (Print)
ISSN 2343-2748 (Online)
ISBN 978-951-51-7009-5 (Paperback)
ISBN 978-951-51-7010-1 (PDF)

Unigrafia
Helsinki 2021

ABSTRACT

The impact of health problems on educational careers attracts multidisciplinary attention, but the overall significance of different types of adolescent health problems for educational stratification is still poorly understood.

This study used longitudinal register data to estimate whether different types of somatic conditions and mental disorders at ages 10–16 predict the non-completion of upper-secondary and tertiary education as well as track choice in upper-secondary education. Impaired school performance was analyzed as a potential mechanism explaining health-related differences in upper-secondary outcomes, whereas upper-secondary track choice was hypothesized to explain differences in attaining tertiary education. Finally, the connection between parental education and health-related selection was examined from two perspectives: parental education as a moderator of the impact of health problems and early health as a mediator of the intergenerational transmission of education.

The data set used in the study covered Finnish children born in 1986–1995 and living in mainland Finland at the end of 2000. Health problems were measured based on visits to inpatient and outpatient care and medication reimbursements. The longest follow-up of educational attainment extended until age 27. In addition to regression models adjusted for several sociodemographic confounders, the study used population-attributable fractions to evaluate the population-level contribution of health problems, g-computation to conduct mediation decompositions, and sibling fixed-effects models to adjust for all factors shared within biological sibships.

Adolescents with health problems were less likely to complete upper-secondary education, more likely to choose the vocational track instead of the general track, and less likely to complete tertiary education even if they had previously completed upper-secondary education. One-fifth of dropout from upper-secondary education was attributable to early-adolescent health problems. Impaired school performance mediated a third of the differences in upper-secondary non-completion and half of the differences in track choice. Regardless of the studied educational outcome, mental disorders showed the strongest associations, less than half of which were explained by confounders shared within sibships. Only certain types of somatic conditions (e.g., epilepsy, heart disease, and spinal disease) predicted impaired educational outcomes, whereas mental disorders showed robust associations throughout their spectrum. High parental education protected against the impact of mental disorders on upper-secondary completion, and health problems explained up to 10% of the differences in upper-secondary education according to parental education.

The results imply that severe health problems in early adolescence have a lasting impact on educational careers, entrenched in the transition to upper-secondary education. Impaired school performance contributes significantly to these associations, but adolescents with health problems also make educational decisions that ultimately lead to lower education. Nonetheless, adolescent health problems explain only a small part of the intergenerational transmission of educational attainment.

TIIVISTELMÄ

Tässä väitöskirjassa tutkitaan, ennustavatko 10–16-vuotiaana esiintyvät somaattiset sairaudet ja mielenterveysongelmat vähäisempää toisen asteen ja korkea-asteen koulutuksen suorittamista. Lisäksi analysoidaan, heijastuvatko erot varhaisnuoruuden terveydentilassa valintaan lukion ja ammatillisen koulutuksen välillä. Yhteyksiä tarkastellaan erikseen vanhempien koulutuksen mukaan, ja nuoruusiän terveydentilaa käsitellään myös mahdollisena koulutuksen ylisukupolvisuutta selittävänä tekijänä.

Tutkimuksessa käytetty rekisteriaineisto muodosti edustavan otoksen lapsista, jotka ovat syntyneet vuosina 1986–1995 ja asuneet Manner-Suomessa vuoden 2000 lopussa. Terveysongelmia mitattiin erikoissairaanhoidon käyntien sekä lääkekorvausten perusteella. Pisimmillään koulutustason seuranta jatkui 27-vuotiaaksi. Analyysimenetelminä käytettiin regressioanalyyseja, väestösyyosuuksien laskemista ja kontrafaktuaalista mediaatioanalyysia. Perhetaustan roolia yhteyksien selittäjänä arvioitiin analysoimalla biologisia sisaruskuntia, joissa vain osa sisaruksista oli kokenut terveysongelmia.

Terveysongelmia kokeneet nuoret suorittivat harvemmin toisen asteen koulutuksen ja valitsivat todennäköisemmin ammatillisen koulutuksen lukion sijaan. He myös saavuttivat harvemmin korkea-asteen koulutuksen, vaikka olisivat aiemmin suorittaneet toisen asteen koulutuksen. Kaiken kaikkiaan terveysongelmien syyosuus kattoi noin viidenneksen toisen asteen koulutuksen keskeyttämisestä. Heikentynyt perusasteen koulumenestys selitti noin kolmanneksen terveydentilan mukaisista eroista toisen asteen koulutuksen suorittamisessa ja noin puolet linjavalinnassa havaituista eroista. Vain tietyntyyppiset fyysiset sairaudet (mm. epilepsia, sydänsairaudet ja selkäsairaudet) olivat yhteydessä matalampaan koulutukseen, kun taas mielenterveysongelmat ennakoivat kauttaaltaan lyhyemmäksi jäävää koulutusuraa. Samassa perheessä kasvaneista sisaruksista keskimäärin lyhimmän koulutuksen suorittivat ne, joilla oli ollut mielenterveysongelmia, mutta vanhempien korkea koulutustaso suojasi toisen asteen keskeyttämiseltä. Yhteensä erityyppiset terveysongelmat selittivät noin kymmenesosan vanhempien koulutuksen mukaisista eroista toisen asteen suorittamisessa.

Väitöskirja osoittaa, että varhaisnuoruudessa ilmenevät mielenterveysongelmat ja tietyt fyysiset sairaudet voivat jättää pysyvän jäljen koulutusuraan. Osa terveyden mukaisista eroista koulutustasossa selittyy heikentyneellä koulumenestyksellä, mutta terveysongelmat ennakoivat matalammaksi jäävää koulutustasoa koulumenestyksestä riippumatta. Vaikka terveysongelmat ovat vahvasti yhteydessä koulutukseen, ne selittävät vain murto-osan koulutuksen ylisukupolvisuudesta.

ACKNOWLEDGEMENTS

Doing a PhD is an overwhelming endeavor in many ways, and I am ever grateful for all support and guidance I received during the process. Given the breadth of the project, it is impossible to name everyone who implicitly contributed to the outcome, but here I would like to raise a symbolic toast to the most obvious contributors and collaborators.

This work was conducted at the Population Research Unit (PRU) of the University of Helsinki. I would like to thank Professor Pekka Martikainen, the head of the unit, for originally recruiting me as a research assistant in 2013 and finally acting as the principal supervisor of this dissertation. It has been a pleasure to work in such a highly achieving and internationally minded research group that is always well-informed of the latest theoretical and methodological developments of its field. Most significantly, my time at the PRU has provided endless possibilities for learning from some of the most competent scholars in population research and social epidemiology. I am also thankful to Pekka Martikainen for ensuring funding for the first steps of the thesis.

In addition to Pekka Martikainen, the supervision team of this dissertation included Dr Heta Moustgaard and Dr Hanna Remes. The four of us began to collaborate already at the time when I was writing my master's thesis, and I am doubly grateful to Pekka, Heta, and Hanna for helping me with two theses in a row. Had I not been able to resort to their exquisite eye for what works and what is essential, I would most likely be still lost somewhere in the thesis jungle. Even when I had some serious doubts about the project, my supervisors never stopped believing in it.

I would like to express my sincere thanks to Associate Professor Steven A. Haas and Professor Juho Härkönen for taking their valuable time to conduct the pre-examination of this thesis. Thank you also to Assistant Professor Elina Kilpi-Jakonen for accepting the invitation to serve as the public opponent.

I warmly thank the steering group members and participants of the Population, Health, and Living Conditions (VTE) PhD seminar for creating a lively and friendly atmosphere for academic discussion. Overall, I reckon that the key to the seminar's continual success is in assembling PhD students based on similar methodological interests rather than strict disciplinary boundaries. Not only did I receive helpful constructive feedback on my own research, I also learned a great deal from the other students' presentations—even when our topics of study had little in common. The regular post-seminar gatherings also provided a great way to become familiar with other PhD students.

For the most part of the project, I was in the privileged position of having received a four-year salaried contract from the Doctoral Program in Social Sciences. Knowing that so much excellent research is being conducted in precarious circumstances, I feel ever more humbled by the freedom of trial and

error that the salaried doctoral candidate position enabled. I would also like to acknowledge the several travel grants that I received from the Doctoral School of Humanities and Social Science during my PhD studies. Additionally, I wish to thank Statistics Finland, the National Institute for Health and Welfare, and the Finnish Social Insurance Institution for—literally—making this study possible by providing all data that were used in the analyses.

Given that it is hardly productive to think about one's thesis all the time, I am happy that I was able to distract myself with other tasks every once in a while. One of the aspects of academic work that I truly enjoyed was teaching practical courses on statistical and demographic methods. Accordingly, I want to thank all co-teachers I collaborated with and all students who participated in the courses. I am also grateful to Professors Mikko Aaltonen and Jukka Savolainen for inviting me to work on a couple of criminological articles. I feel that combining different disciplinary perspectives within the same study is a growing but still underutilized source of creativity in academia.

In addition to my supervisors, I wish to thank all the other present and former members of the Population Research Unit I have had a chance to get to know and spend time with both inside and outside of Unioninkatu 35, including Elina Brandt, Elina Einiö, Elina Hiltunen, Julia Hellstrand, Liina Junna, Kaarina Korhonen, Fanny Kilpi, Hannu Lahtinen, Taina Leinonen, Juha Luukkonen, Niina Metsä-Simola, Jessica Nisén, Joonas Pitkänen, Karri Silventoinen, Outi Sirniö, Lasse Tarkiainen, and Ulla Suulamo, among others. When conducting research, it is a delight to be surrounded by such a skillful group of other researchers working with similar data and methods. I especially enjoyed our reading circles, which provided a venue to delve into complex methodological issues with a collaborative approach.

Finally, I want to thank all colleagues, friends, and family members who inspired and encouraged me in my academic undertakings (or simply provided something else to think about). Many thanks to my past co-workers at the Research Foundation for Studies and Education (Otus): it can hardly be emphasized enough how influential this experience was for my development as a researcher and data analyst. When it comes to my friends, Karoliina Suonpää deserves special thanks for being my closest academic peer throughout the PhD journey. Thank you Aishi, Henri, Jonni, Katariina, Maria, Petri, Teemu, and Tiina, among others, for your wonderful company over the past few years! Kiitokset äidille ja Sandralle rakkaudesta, tuesta ja kannustuksesta!

Helsinki, April 2021 (i.e., the second year of the COVID-19 pandemic)

Janne Mikkonen

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I **Mikkonen, J.**, Moustgaard, H., Remes, H., & Martikainen, P. (2018). The population impact of childhood health conditions on dropout from upper-secondary education. *The Journal of Pediatrics*, 196, 283-290.

II **Mikkonen, J.**, Remes, H., Moustgaard, H., & Martikainen, P. (2020). Early Adolescent Health Problems, School Performance, and Upper Secondary Educational Pathways: A Counterfactual-Based Mediation Analysis. *Social Forces*, 99(3), 1146-1175.

III **Mikkonen, J.**, Remes, H., Moustgaard, H., & Martikainen, P. (2020). Evaluating the Role of Parental Education and Adolescent Health Problems in Educational Attainment. *Demography*, 57(6), 2245-2267.

The publications are referred to in the text by their Roman numerals. Sub-studies I and III are published under an open access license (CC BY). Sub-study II is reproduced with the kind permission of the copyright holder in the printed version of the thesis.

Author contributions: In all three sub-studies, Mikkonen processed the data, conducted the statistical analyses, wrote the manuscript draft, and revised the manuscript based on reviewer feedback. Martikainen, Moustgaard, and Remes oversaw the development of the study design and analyses and suggested edits for the manuscript.

ABBREVIATIONS

ADHD	Attention-deficit hyperactivity disorder
CI	Confidence interval
ICD	International Statistical Classification of Diseases and Related Health Problems
ISCED	International Standard Classification of Education
PAF	Population-attributable fraction
RR	Relative risk / risk ratio
SEP	Socioeconomic position

1 INTRODUCTION

During the latter half of the 20th century, average educational attainment increased drastically in Finland and other developed countries (Schofer and Meyer 2005). While this unprecedented shift in access to education—commonly referred to as educational expansion—has been occasionally seen to drive degree inflation (Campbell 2009), highly educated individuals have retained their advantaged position in terms of lower unemployment risk, higher earnings, longer life expectancy, a greater autonomy at work, and a better quality of life (Cairó and Cajner 2018; Edgerton, Roberts, and von Below 2011; Elo 2009; Psacharopoulos and Patrinos 2018). Although education operates to some extent as a signal of abilities and skills unrelated to the education in itself, vast evidence highlights education as one of the central shapers of individual life chances and connects school leaving early with increased welfare dependency (Hout 2012). In fact, it is conceivable that the significance of higher education has only increased with the ongoing developments in workplace automation and offshoring, hitting the hardest in sectors employing many low- and medium-skilled workers (Arntz, Gregory, and Zierahn 2016; Becker, Ekholm, and Muendler 2013).

When it comes to educational trajectories, there is hardly a more influential period of life than *adolescence* covering the age range of 10–19 years. With the end of compulsory schooling, individuals are required to make far-reaching educational decisions and may in some cases even terminate their education for good (Dahl et al. 2018). Given that all of this happens in parallel with the most intensive physical and neurological development since infancy, life course theoreticians have increasingly begun to identify adolescence—especially early adolescence involving the start of puberty—as a sensitive period paving the way to advantage and disadvantage experienced in adulthood (Johnson, Crosnoe, and Elder Jr. 2011). With so much at stake, any additional hardships and disruptions experienced in adolescence could cause particular harm.

During the past two decades, there has been a surge of interest in the role of health problems as potential disturbers of educational careers—an idea often referred to as *health-related selection to education* or simply *health selection*. In this context, it has become almost a truism to notice that while the influence of education on health has received much scientific attention, the impact of health on education is both understudied and poorly recognized (Hale, Bevilacqua, and Viner 2015; Suhrcke and de Paz Nieves 2011). At the same time, a host of systematic reviews demonstrates that the shortage of evidence pertains to quality rather than quantity. There is a lot of empirical research observing health–schooling associations, but most of it is hampered by retrospective or cross-sectional data, limited health indicators, short follow-ups of educational outcomes, and poor control for confounding (Esch

et al. 2014; Hale et al. 2015; Melkevik et al. 2016; Suhrcke and de Paz Nieves 2011). From a theoretical point of view, it would be useful to connect health selection research more closely to the mainstream sociological discussion on educational stratification and intergenerational inequality.

The main objective of this study is to provide a more complete picture of health-related selection to education than has been previously available. Whereas previous studies have predominantly focused on self-rated health and self-reported health conditions (Suhrcke and de Paz Nieves 2011), the present investigation uses register data on medical diagnoses and medication reimbursements to produce comparable evidence on the educational consequences of early-adolescent somatic conditions, mental disorders, and injuries. The associations are examined based on both broad groups of health conditions and specific health conditions. Moreover, by using register-based longitudinal data the study is able to assess selection taking place at different levels of education ranging from school performance at the end of compulsory schooling and upper-secondary school dropout to track choice in upper-secondary education and the completion of tertiary education. Instead of estimating only bivariate associations, the study sheds light on the path-dependent nature of selection by treating school performance as a mediator of health-related selection to upper-secondary education and upper-secondary track choice as a factor explaining selection to tertiary education. Finally, the study produces novel evidence on the connections between social origin and health selection by examining whether parental education moderates the association between health problems and education and whether health problems mediated the intergenerational transmission of educational attainment.

The dissertation comprises three articles published in international peer-reviewed journals. The present summary article highlights the connections between the individual studies, both theoretically and empirically, and includes background material that could not be fitted within the strict word limits of academic journals. Before starting, it is good to mention a few things regarding terminology. Both the summary and the individual articles use "health problems" and "health conditions" as interchangeable umbrella terms that capture all aspects of poor health in childhood and adolescence. However, they are considered to refer to realized states of health rather than health behaviors that could cause poor health in the long run, such as smoking or low physical activity. Although the idea that health behaviors and school performance go hand in hand carries a lot of significance, the role of health behaviors falls beyond the scope of the present dissertation.

Other catchall phrases featured throughout the work are "somatic conditions" and "mental disorders." The former refers to all types of somatic illnesses regardless of their severity or chronicity, while the latter is used as a shorthand for psychiatric and neurodevelopmental disorders. Finally, the expressions "health-related selection to education" and "health selection" are used in a neutral manner to refer to the suggested causal effect of health status

on education and on any social outcome, respectively. Despite the connotation of the word "selection," current health selection research does not presume that adolescents with health problems *select* (i.e., *choose*) not to continue education (von Hippel and Lynch 2014); there could also be structural barriers that discourage them from continuing.

2 HISTORICAL AND THEORETICAL BACKGROUND

2.1 THE CHANGING PICTURE OF CHILDHOOD ILLNESS AND DISABILITY

The notion of childhood illness and disability saw an unprecedented shift in the course of the 20th century. In Finland, infant mortality declined from around 70 per 1000 in the mid-1930s to less than 3 per 1000 in 2010 (Statistics Finland 2011). Correspondingly, annual mortality among children aged 1 month to 15 years declined from 0.67 per 1000 in 1969 to 0.23 per 1000 in 2004 (Lantto, Renko, and Uhari 2008). Similar, albeit often less dramatic, trends have been documented throughout the industrialized countries, and they are predominantly explained by the more effective prevention and treatment of congenital malformations, infectious diseases, and other acute conditions (Halfon and Newacheck 2010). Simultaneously, advancements in other areas of medicine have enabled survival from many life-threatening conditions that were previously considered untreatable, such as many forms of childhood cancer (Halfon and Newacheck 2010; Lantto et al. 2008). With improved regulation and environmental safety, the incidence of fatal injuries in children and adolescents has been constantly decreasing (Parkkari et al. 2016, 2020). In Finland, a particularly large drop has been observed in drownings and road traffic injuries (Parkkari et al. 2016).

In consequence of decreased early mortality as well as developments in diagnostics and recognition, the proportion of children categorized as living with a *chronic condition* increased notably towards the start of the 21st century (Van Cleave, Gortmaker, and Perrin 2010). For a health condition to be considered chronic, it typically has to last for a minimum of 12 months and be severe enough to induce at least some level of activity limitation (Van Cleave et al. 2010; Halfon and Newacheck 2010). This definition does not differentiate between physical health conditions and mental and neurodevelopmental disorders, although many authors use the term either explicitly or implicitly to refer to long-term physical illnesses (Bell et al. 2016; Compas et al. 2012; Maslow et al. 2011).

Impairment and disability are other closely related concepts in this context, and they are probably also the most controversial ones. In the field of disability studies, it is typical to distinguish between the traditional "medical model" of disability and the competing "social model" of disability. In the former line of thinking, disability is considered a problem of the body that requires treatment or at least adaptation; disabilities are linked to disadvantage through the functional limitations they cause (Goering 2015). By contrast, the social model of disability contests the medical approach by emphasizing that the largest obstacles disabled individuals usually face are

related to the built physical environment and other people's attitudes (Goering 2015). It makes a clear distinction between impairments—defined as a non-standard state of the body, such as low vision or hearing loss—and disabilities, which are restrictions of activity that individuals with impairments face in the physical and social environment (Anastasiou and Kauffman 2013). The concept of disability is importantly connected to the present thesis because schooling is arguably the most important indicator of functioning in children and adolescents and an area of life that seems especially vulnerable to experiences of disability.

The prevalence of chronic illness or disability among Finnish school-aged children depends strongly on the way it is measured. In 2018, there were 305,538 children aged 10–14 in Finland, of whom 22,672 (7.4%) had an eligibility for reimbursed long-term medication, issued by a medical specialist (Statistics Finland 2020b; The Finnish Social Insurance Institution 2020). This figure represents a group of physical health conditions that are widely recognized as requiring constant medication (e.g., type 1 diabetes, epilepsy, and rheumatoid arthritis) and is, as such, an underestimate of the overall disease burden. In a school health survey conducted in 2019, 21.3% of early adolescents attending the 8th or 9th grade reported that they had a long-term illness or health problem diagnosed by a physician (The National Institute for Health and Welfare 2019). Although more subjective and vague in its definition, this figure is likely to cover a broader range of childhood health problems. In comparison, 26.6% of children aged 8–14 in the United States were estimated to have a chronic condition (obesity and behavior/learning problems included) in 2006 (Van Cleave et al. 2010). In their systematic review, van der Lee et al. (2007) document the large variety of operationalizations used in different studies measuring the prevalence of chronic health conditions in children: depending on the definition, the prevalence of chronic conditions can be anything from 0.22% to 44% in wealthy countries.

Investigations reaching the largest prevalence estimates typically take into consideration a broad range of emotional, behavioral, and neurodevelopmental disorders. A study from the United States documented an overall lifetime prevalence of 22.2% for mental disorders involving severe impairment or distress in adolescents aged 13–18 based on face-to-face surveys (Merikangas et al. 2010). Another investigation from the United States documented a simultaneous decline in disability related to physical conditions and an increase in disability related to mental or neurodevelopmental conditions, which resulted in a 16% overall increase in activity-limiting disabilities among children under 18 between 2001 and 2011 (Houtrow et al. 2014).

In studies measuring healthcare use, the prevalence of psychiatric and neurodevelopmental diagnoses among children and adolescents has shown a constant increase during the past decades. In a Finnish study comparing children born in 1987 and 1997, the cumulative prevalence of diagnoses

received at ages 12–18 increased from 9.8% to 14.9% among girls and from 6.2% to 8.8% among boys (Gyllenberg et al. 2018). Unipolar depression and other anxiety disorders showed the largest increases among girls and in emotional and social interaction disorders and attention-deficit hyperactivity disorder (ADHD) among boys. Similarly, a multinational comparison study combining data from Finland, Sweden, Denmark, and Western Australia observed a notable increase in diagnoses of childhood autism, hyperkinetic disorder, obsessive compulsive disorder and Tourette syndrome between birth cohorts 1990–1992 and 2005–2007 (Atladottir et al. 2015). The question of whether the true population prevalence of mental and neurodevelopmental disorders has increased is much debated, although a careful reading of the available literature suggests that these trends are more likely explained by an increased awareness and an improved recognition of disorders at different levels of healthcare (Atladottir et al. 2015; Gyllenberg et al. 2018).

2.2 WHAT'S IN A NAME? HEALTH SELECTION AND ITS MANY COUSINS

The idea that poor health could negatively affect social outcomes has a long and disjointed history. The concept of "health selection" (or "social selection") has been traditionally used by sociologists and social epidemiologists studying disparities in health and mortality according to socioeconomic position (SEP), most typically defined through occupational position, education, or income (Elo 2009). In this line of inquiry, Ogle (1885, cited by Fox and Collier 1976) is often noted as the first to suggest that comparing occupational mortality rates is complicated because "some occupations repel, while others attract, the unfit" and, correspondingly, "some occupations may be of necessity recruited from men of supernormal physical condition."

In the United States, Perrott and Collins (1935) proposed a similar interpretation for their results showing that families reduced to poverty during the Great Depression experienced more disabling illness. The authors even suggested two separate theories of selection, the first referring to "sickness *per se* as a cause of unemployment" and the latter proposing "an inherent inferiority of which unemployment was one manifestation and ill health another." With this distinction, their framework seemed to foreshadow the division between direct and indirect selection, common in later health selection literature (West 1991). Despite highlighting selection as an alternative explanation, the authors concluded, "It seems highly improbable that a theory of selection contains the sole explanation of the results of the present survey." (Perrott and Collins 1935).

In the United Kingdom, Illsley (1955) contributed to the selection literature by showing that "women who rose in social status at marriage already possessed advantages in terms of growth, health, and education (…) and were more efficient at child-bearing than women less favored." Illsley interpreted

these results as evidence that "selective interchange between classes at marriage tends to accentuate class differences, and is partly responsible for the continuing disparity between the mortality rates of the Registrar-General's social classes." As noted by West (1991), the early examples of health selection research were often met with accusations of promoting a social Darwinist worldview where the social class structure is the sole result of innate individual attributes, including health. While the abundant language of "fitness" and "superiority" may have contributed to this interpretation, political bad faith was likely involved in the critique as well. In the United Kingdom, the early 1980s saw the publication of the Black Report on health inequalities (Department of Health and Social Security 1980), which is often considered a key milestone in the history of social epidemiology. As one of the four theoretical explanations for health inequalities, the report included "natural and social selection," which received a much shorter introduction than the three other theories.

In hindsight and following West (1991), it is easy to hear a dismissive tone in the words the authors of the Black report used to describe selection: "In this approach, social class is relegated to the status of dependent variable while health itself acquires the greater degree of causal significance. The occupational class structure is seen as a filter or sorter of human beings and one of the major bases of selection is health, ie. [sic] physical strength, vigour or agility." (Department of Health and Social Security 1980) Moreover, as noted by Vågerö and Illsley (1995), the very use of the word "natural selection" seemed symptomatic given that previous authors on health selection had made no reference to Darwin's theory.

Only during the 1990s did the antagonistic reputation of health selection research begin to slowly dissipate when health selection was increasingly re-conceptualized as "social" and "sociological" (Cardano, Costa, and Demaria 2004). For West (1991), this meant relinquishing the conception that health selection is an entirely biological or genetic process and acknowledging that health selection is ultimately a form of discrimination, realized in the opportunity structures of educational institutions and the labor market. Understood this way, discrimination due to illness and disability belongs to the same category as discrimination because of sex or race—and should be treated accordingly (West 1991). Gradually, health disparities research has proceeded towards assessing the relative contribution of social causation and health selection simultaneously (Lynch and von Hippel 2016). With the adoption of a life course approach, the answer to the question of causation versus selection is increasingly both-and rather than either-or because the effects of causation and selection on health disparities could operate reciprocally and depend on the stage of life (Hoffmann, Kröger, and Pakpahan 2018).

Social epidemiologists are not the only ones who have been interested in examining the effect of health on SEP and vice versa. Especially since the 1990s, economists have been using their own theoretical approaches and

methods to provide novel insight on the discussion (Adams et al. 2003; Case, Lubotsky, and Paxson 2002; Deaton and Paxson 1998; Schultz 2002; Smith 1999). They commonly use the term "health shock" to refer to health problems (Eide and Showalter 2011; Fletcher and Richards 2012), which can be seen to emphasize the sudden and unexpected nature of many serious health conditions. Whereas social epidemiologists have—at least traditionally—focused more commonly on occupational position, economists tend to put greater emphasis on income and education, with the latter typically referred to as human capital (Case et al. 2002; Ding et al. 2009; Fletcher and Richards 2012; Fletcher and Wolfe 2008; Smith 2009). While some economic studies comment on the health disparities debate, most of them are rather negligent of it and examine the impact of health problems on the formation of human capital and economic prospects as an independent phenomenon. Overall, literature reviews conducted by economists seem largely unconcerned with the work conducted on health selection in other fields of study (Eide and Showalter 2011).

If economists have shown occasional interest toward the social epidemiological debate on causation vs. selection, pediatricians and child psychologists approach the social consequences of health problems with a completely different vocabulary. As part of a broad definition of clinical outcomes, the outcomes of healthcare can be divided into health outcomes and social outcomes, which are sometimes assessed in the same study (Liptak and Accardo 2004). Researchers in this tradition often use validated instruments to measure coping, psychosocial functioning, and health-related quality of life in children with chronic conditions or other special healthcare needs (Emerson et al. 2015; Forgeron et al. 2018; Grootenhuis et al. 2007; Schmidt, Petersen, and Bullinger 2003). However, many pediatric studies examine educational and employment outcomes as well (Barbaresi et al. 2007; Bell et al. 2016; Berg et al. 2016; Boman, Lindblad, and Hjern 2010; Maslow et al. 2011), and the problem of school absenteeism among children with chronic illnesses has been recognized in the literature for a long time (Weitzman et al. 1982). The term "health selection" appears rarely in the pediatric literature, however.

During the past two decades, there has been a surge of social scientific research that is indebted to all of the above-mentioned approaches. This line of research commonly identifies two distinct forms of selection—*drifting* and *stunting* (Layte and McCrory 2013). In the former, a person who has already achieved a certain SEP drifts to a lower one because of health problems. This process is sometimes referred to as *intra-generational downward mobility*, and it pertains to, for instance, working-age adults with mental disorders who become unemployed (McLeod and Kaiser 2004). By contrast, the process of stunting applies to children and adolescents whose socioeconomic development, namely educational career and labor-market entry, is hindered by early health problems (Layte and McCrory 2013). Whereas drifting has traditionally received much more theoretical and empirical attention, the new

forms of social scientific health selection research have been particularly engaged with the process of stunting.

Similar to economics, this emerging research orientation is interested in understanding the process of selection in itself (Palloni 2006). The association between mental disorders and educational outcomes has received particular attention, with attempts to combine sociological and psychological theory to understand its mechanisms (McLeod and Fettes 2007; McLeod and Kaiser 2004). What is particularly sociological about the new approach is that it connects health selection to social stratification and highlights the potential of childhood health disparities in explaining the intergenerational transmission of SEP (Haas 2006; Palloni 2006), noted only occasionally in economic research (Aizer and Currie 2014; Case et al. 2002). Along the same lines, it is acknowledged that some social contexts could be protective while others could increase vulnerability to the effects of childhood health problems on socioeconomic attainment (Evensen et al. 2016; Jackson 2009).

The present dissertation builds on this new phase of health selection research, which barely identifies itself as a research program at all. No effort is made to proclaim the superiority of this perspective over the others mentioned above; instead, the goal is to prove that the approach is meaningful and worthy of social scientists' attention. The traditional social epidemiological reading of health selection equates the usefulness of selection studies with their ability to explain socioeconomic health disparities (Blane, Smith, and Bartley 1993; Warren 2009). That view can be rejected for two reasons. First, health conditions that affect SEP could be different than—and even unrelated to—health conditions that exhibit social disparities in adulthood. Second, the weak overall contribution of health selection to social disparities in health is not necessarily a sign of weak health selection per se: perhaps health conditions that show the greatest selection effects are simply too rare to explain much of social disparities at the population level. Thus, although health selection was originally introduced as an alternative explanation to social disparities in health, in its current form health selection research is at least as much about explaining variation in educational and labor-market outcomes.

2.3 THE MECHANISMS OF HEALTH SELECTION

A number of theoretical models have been proposed to explain the selection of individuals with health problems into lower levels of education. Because of the relative novelty of the stunting perspective to health selection and the singularity of different approaches, little effort has been made thus far to integrate these theories into a unified model of health-related selection to education. This chapter echoes Lynch and von Hippel (2016) by classifying the previously suggested theoretical models into four groups: bio-cognitive explanations, social explanations, economic/psychological explanations, and

confounding explanations. It is conceivable that the weight of different explanatory models depends on both contextual factors and the type of health problem in question.

2.3.1 BIO-COGNITIVE EXPLANATIONS

This line of thinking connects poor early health with impaired cognitive development and, subsequently, learning difficulties and weak performance at school. The idea is particularly prominent in studies assessing the developmental and social consequences of adverse birth outcomes, such as prematurity and low birthweight. Bio-cognitive explanations are profoundly connected with the pioneering work of David Barker who developed the fetal programming hypothesis, often dubbed "the Barker hypothesis." In its original form, the fetal programming hypothesis states that disproportionate growth caused by undernutrition during critical periods of fetal development "programs" irreversible changes in organs and tissues, leading to an elevated disease risk later in life (Barker 1995). The framework of life course epidemiology uses the concept *critical period* to refer to the time windows of human development that are especially vulnerable to biological programming (Kuh et al. 2003).

Although the "long arm" extending from fetal environment to old age chronic disease has been part and parcel of the Barker hypothesis, the life course epidemiological theory on critical periods has also attracted a plethora of studies connecting early growth patterns and harmful fetal exposures with child, adolescent, and young adult outcomes. In this brand of research, cognitive and neurodevelopmental outcomes have typically been at center stage. A number of meta-analyses have connected preterm birth and low birth weight with attention problems and poorer cognitive test scores among school-age children (Aarnoudse-Moens et al. 2009; Barre et al. 2011; Bhutta et al. 2002). According to a Finnish study, slow growth during three critical periods up to age 7 years predicts weaker verbal, visuospatial, and arithmetic abilities at age 20 (Räikkönen et al. 2009). In addition to nutritional factors, previous studies have cited maternal smoking and exposure to ambient air pollution as notable environmental risk factors of restricted growth (Bernstein et al. 2005; Ha et al. 2001).

Even more significantly for the present study, certain types of chronic conditions in childhood are associated with an elevated risk of impaired cognitive development. One of these conditions is type 1 diabetes, which has been connected with deficits in several branches of cognition (Brands et al. 2005; Gaudieri et al. 2008). Although the associations are in general relatively weak, early age of onset (under seven) increases the risks (Gaudieri et al. 2008). Brain imaging studies suggest coexistent alterations in brain structure, supporting an organic explanation for the documented cognitive deficits (Ferguson et al. 2005). Other important health conditions carrying a potential of cognitive impairment include epilepsy and central nervous system tumors,

which could cause cognitive deficits both because of the harmful effects of the condition on the brain and because of treatment methods and medication (Anderson et al. 2001; Hermann and Seidenberg 2007). However, in the case of epilepsy, the direction of causality has been questioned by studies showing cognitive impairment already at the time of diagnosis or even preceding it (Oostrom et al. 2003).

2.3.2 SOCIAL EXPLANATIONS

Sociological studies in particular highlight the importance of structural barriers and interactional factors in explaining health-related differences in educational outcomes. It has been suggested that children with health problems perform worse at school simply because they are obliged to be absent from school more often than their peers, thus losing out on the benefits of classroom instruction (McDougall et al. 2004; Needham, Crosnoe, and Muller 2004). This type of process can be seen as a failure of education organizers to compensate for the school days that were missed because of symptoms, treatment, or recovery. At the same time, the problems of absenteeism could take a more subtle form among students who are physically but not mentally present in the classroom. Children who experience painful physical symptoms or emotional disorders may find it difficult to concentrate on teaching or to form meaningful bonds with their teachers and classmates (Needham et al. 2004).

Compared to all other explanations of health selection, increased unintentional school absenteeism is supposedly one of the most context-specific, and results obtained in one educational context may not be readily generalizable to other countries. In Canada, children with activity-limiting conditions have around twice the number of absent days compared with other children (McDougall et al. 2004), whereas among children with asthma, there seems to be a dose–response relationship with asthma severity level and missed school days in the United States (Moonie et al. 2006). According to a study from England, school absences could be an important mediator of the associations between chronic conditions and early-adolescent educational attainment (Hale and Viner 2018). In Finland, it should be noted that in the most severe cases of illness children may receive teaching in 1 of the 25 hospital school units located in the largest cities of the country (Sairaalaopetus 2020).

In the same way as the social model of disability emerged as a critique of the traditional medical model, the sociological interpretations of health selection have criticized clinicians and epidemiologists for equating the social consequences of emotional and behavioral disorders with disorder severity (McLeod, Uemura, and Rohrman 2012). Instead of focusing only on the child's readiness to absorb knowledge and be present at school, these perspectives turn their attention to the social responses that children with mental disorders receive from other people at home and in the school environment (McLeod

and Fettes 2007). As a theoretical motivation, they invoke the concepts of stigma, labeling, discrimination, and social exclusion.

The most famous definition of stigma was presented by Erving Goffman who identified stigma as a behavioral or physical attribute that causes a person to be socially devalued and rejected because it is, for the moment, discredited by society (Goffman 1986:3). Stigma becomes connected to mental disorders through the labeling theory (Scheff 1974) and, nowadays, especially through the modified labeling theory (Link et al. 1989). Whereas the former theory considers mental illness a culturally constructed label that the labeled persons themselves start to fulfill in their behaviors (thus producing the illness as a kind of self-fulfilling promise), the latter asserts a more intricate process where the fear of discrimination, learned through socialization, prepares individuals with mental disorders to anticipate rejection and withdraw from social situations thus weakening their self-esteem and social support networks (Link et al. 1989).

In a study on children's stigmatization, other children were more willing to keep social distance from children with ADHD or depression than from children with asthma, and ascribed stronger expectations of violence and antisocial behavior to these conditions (Walker et al. 2008). A qualitative study on stigma experiences among adolescents with emotional or behavioral disorders reported peers, parents, and school staff alike as important sources of stigmatization (Moses 2010). Adolescents taking psychiatric medication have also been shown to exhibit patterns of behavior described in the modified labeling theory, such as shame, secrecy, and limiting social interaction (Kranke et al. 2010).

The contemporary accounts of youth stigmatization typically understand the negative social response as a combined consequence of symptomatic behaviors and labeling (Moses 2010). In the school environment, children with attention or conduct problems are especially likely to elicit negative social response because their behavior is easily seen as distractive and interpreted to signal disinterest toward educational achievement (McLeod et al. 2012). Disruptive behaviors can lead to negative interactions with peers and teachers who may ultimately come to withdraw their intellectual and social support (Roeser, Eccles, and Strobel 1998). In a captivating study on "behavior penalties" in grading, adolescents with conduct or attention problems received systematically weaker grades from their teachers than their performance in anonymously rated exams seemed to predict (Evensen 2019).

Although emotional and behavioral disorders have been both theoretically and empirically salient for stigmatization perspectives, similar concepts have been applied for explaining why adolescents with a high body mass index seem to end up with lower educational attainment (von Hippel and Lynch 2014). Obesity is a highly stigmatized attribute, and evidence implies that discrimination due to body weight is considered more socially acceptable than discrimination due to other traits, such as religion or sexual orientation (Latner et al. 2008). An investigation by Crosnoe (2007) notes that obese

adolescent girls' experiences of emotional distress, elevated self-medication through substance use and declined academic engagement explain roughly one-third of their lower odds of entering college. Notably, the low prevalence of obesity in the same educational institution—a likely trigger of increased stigmatization—predicted stronger associations.

2.3.3 ECONOMIC/PSYCHOLOGICAL EXPLANATIONS

Education can be seen as an investment that consumes plenty of time (as well as money in many countries) and pays back only in the long term. Economists exploring health selection have favored a psychologically oriented explanation that notes the effect of health problems on individual time preference: persons encountering serious health problems are inclined to shift their preferences from future goals toward immediate gratification because experiences of poor health lower subjective life expectancy (Smith 1999). In the economic parlance, health shocks cause a person to discount future utility and value present utility (Becker and Mulligan 1997). When it comes to young people making significant educational transitions, such changes in time preference could be decisive because young people in general tend to exhibit high levels of future discounting (Steinberg et al. 2009).

Psychologists would approach the same phenomenon through the concept of *future orientation*, which has been shown to be a significant predictor of educational engagement among young people (Horstmanshof and Zimitat 2007; Scholtens, Rydell, and Yang-Wallentin 2013). A person with strong future orientation exhibits little future discounting, and vice versa. In a previous study from Sweden, ADHD symptoms in adolescents predicted lower levels of future orientation, both directly and through lower academic achievement (Scholtens et al. 2013). A sociological reading of the connection between future orientation and education highlights its social underpinnings through the concept of *educational expectations*. As noted by Jackson (2009), parents who have a child encountering health problems may emphasize well-being and recovery over academic performance, and the children themselves may start to believe they are limited by health problems. Similarly, both children and their parents could interpret challenges faced at school as further evidence of a need to lower their expectations. In the worst-case scenario, teachers and school counselors could reinforce this pattern with their own negative expectations (McLeod and Fettes 2007).

2.3.4 CONFOUNDING EXPLANATIONS

While there are good reasons to assume causality between health–schooling relationships, early health and educational outcomes also share some common background factors that are likely to confound the bivariate associations. Prior health selection literature commonly described this process as *indirect selection* (Blane et al. 1993; West 1991), but nowadays it is typically considered

confounding because the actual interest is in the direct effect of health problems on education, mediated by the mechanisms outlined above (Lynch and von Hippel 2016). Among the suggested confounders, different aspects of parental SEP (education, income, and occupation) are the ones that appear most commonly in the literature (Hale et al. 2015; Melkevik et al. 2016). Parental education is a strong predictor of offspring educational attainment (Hertz et al. 2007), and there are meaningful disparities in early health according to different dimensions of parental SEP (Currie 2011; Reiss 2013; Viner et al. 2012). On the other hand, if resource allocation within families is determined by the expected probability of future success (Becker and Tomes 1986), parents may come to invest less time and money in their offspring with poor health (Hsin 2012).

Although alterations in time preference count as potential mechanisms explaining the effect of health on education, individual differences in time preference (or future orientation) could also operate as confounders of the relationship. More technically, the former scenario would signify an *endogenous* determination of time preference, whereas the latter would be a sign of *exogenous* determination (Becker and Mulligan 1997). Fuchs (1980) originally noted the possibility of time preference, consolidated at an early age, explaining the putative effect of education on health, but the interpretation applies partly to the effect of health on education, as well. While most health outcomes in childhood and adolescence are unrelated to the person's own actions, lifestyle choices may leave room for individual time preference. Some authors on obesity have noted that a preference toward immediate gratification could guide the same person to both lead a sedentary lifestyle and discontinue education (von Hippel and Lynch 2014).

When time preferences and future orientation are considered to precede both health and education, they are best characterized as either innate or early-adopted psychological traits (Lynch and von Hippel 2016). Another possibly relevant psychological trait is intelligence, which is a strong predictor of both health and education (Gottfredson 2004). Given that intelligence remains rather stable throughout the lifespan (Deary, Pattie, and Starr 2013), it could be an important confounder in health–schooling relationships regardless of their direction. Among the Big Five personality traits, high conscientiousness seems to be particularly predictive of both positive health behaviors and educational outcomes (Bogg and Roberts 2004; Poropat 2009; Tackman et al. 2017), and within the broader group of *non-cognitive skills*, high self-control—the ability to resist urges and override impulses—and self-esteem—the degree of approval toward oneself—are similarly important (Hagger 2014; Stadler et al. 2016; Zheng 2017).

2.4 SOCIOLOGICAL PERSPECTIVES ON EDUCATIONAL STRATIFICATION AND HEALTH SELECTION

Education is a key component in the sociological literature on social stratification—the study of how and why societies categorize individuals into hierarchical social groups (Bukodi and Goldthorpe 2016). In the Durkheimian tradition of explaining social processes with "social facts"—constraining factors external to the individual—mainstream sociological discussions have most commonly examined stratification in education according to extra-individual group-level properties, such as parental social class, ethnicity, and gender (Breen and Jonsson 2005). Consequently, the same reasons encouraging the original downplaying of health selection explanations in social disparities research may have resulted in the neglect of early health problems in stratification studies.

Every now and then, this lack of connection has been noticed by researchers aligned with the tradition of disability studies. Jenkins (1991) argued that disabled individuals are "practically invisible" to mainstream forms of sociology, such as stratification studies. According to his reading, stratification studies have traditionally regarded social class as the principal mode of stratification, which has led to the neglect of disabilities on similar grounds as gender and ethnicity were neglected previously. Notably, Chatzitheochari and Platt (2019) draw a very similar conclusion on the role of disabilities in stratification research 28 years later: "Disability differentials have been largely overlooked in social stratification and life course research." They mention the lack of suitable longitudinal datasets as a potential explanation for the limited number of sociological studies exploring these questions. Even in the early 2000s, Priestley (2001) and Powell (2003) prompted a stronger integration of disability into sociological stratification and life course research.

Many concepts originally introduced in connection to social class differences in education are readily applicable to the study of stratification in educational attainment according to health problems. The transition model of educational attainment hypothesizes that the impact of parental SEP declines with each successful educational transition (Mare 1980). Thus, instead of measuring years of completed education, a more nuanced view of stratification may be achieved by examining stratification in the sub-group of individuals who managed to complete the previous level of education, such as stratification of tertiary education among those attaining a secondary degree. Here, it is important to separate between enrollment and completion because dropping out from education is likely to be selective as well and completing some courses is unlikely to provide similar benefits as attaining a degree (Contini, Cugnata, and Scagni 2018).

On the other hand, it has been understood for a long time that analyzing educational careers as sequences of transitions may also produce an oversimplified picture of stratification because the same level of education

consists of alternative tracks or branches of study in many education systems (Breen and Jonsson 2000). If study track decisions affect career opportunities or possibilities of pursuing further education, it seems likely that stratification occurs in this dimension as well (Gerber and Cheung 2008). Accordingly, it is possible to distinguish vertical (the level of education) and horizontal (different tracks within the same level) dimensions of stratification (Charles and Bradley 2002); however, these are not completely separate because horizontal stratification can elicit subsequent vertical stratification (Breen and Jonsson 2000).

Even if a person is able to complete a certain level of education, it is not guaranteed that the person can simply decide to continue to the subsequent level, let alone freely choose any of the alternative fields of study. Boudon (1974:29–31) is known for originally introducing the distinction between the primary and secondary effects of social class on educational attainment. The primary effects refer to the impact of parental social class on school performance and therefore define the range of available educational options. Secondary effects, in turn, capture the remainder of social class differentials in educational attainment operating above and beyond differences in school performance. Research has shown evidence for both types of effects: children coming from a socioeconomically disadvantaged background perform worse at school, but they also seem to make less academically oriented educational choices within the range enabled by their past educational performance (Erikson and Rudolphi 2010; Jackson et al. 2007). Considering that different education systems use different methods for selecting students, the primary and secondary effects do not automatically translate into a simple dichotomy of abilities vs. decisions. For instance, grade point averages used in many systems are likely to reflect not only abilities but also behaviors appreciated by teachers (Erikson and Rudolphi 2010; McLeod et al. 2012).

Applying these concepts to the study of health-related differences in educational attainment makes the interpretation of previous evidence on health selection clearer and yields novel hypotheses to test empirically. It is conceivable that the impact of early health problems diminishes with each successful transition. At the same time, it is plausible that the analysis of immediate enrollment and ultimate completion yields different results because health problems may also increase the risk of terminating education. A more nuanced view of health-related differences in education could be achieved by simultaneously analyzing the vertical and horizontal dimensions of stratification; horizontal stratification could also be important in explaining vertical stratification in the subsequent level of education. To truly understand the nature of health-related selection to education, it is important to separate between the primary and secondary effects of health problems, namely the part explained by weakened school performance and the part remaining after accounting for past performance.

2.5 THE CONTEXTUAL AND INTERGENERATIONAL ASPECTS OF HEALTH SELECTION

Health-related selection to education is often studied in a manner that isolates it from the broader social context: health problems and educational attainment are measured at two separate time points and their association is estimated by either adjusting for as many potential confounders as possible or employing a study design that automatically repudiates many alternative explanations (e.g., comparisons of full siblings discordant for health status). This approach is useful when the goal is to evaluate the very existence of health selection or compare the effects of different types of health problems, as is done in some parts of the present dissertation. However, to complete the picture, these "foundational" studies need to be complemented with perspectives that evaluate the connections between health selection and other forms of childhood adversity. Although any child can potentially develop a serious health condition, both the likelihood and the consequences of this event depend on the material and cultural resources of the family.

Cumulative inequality theory, which combines the key elements of *cumulative advantage* and *life course* theories, offers a fruitful way to address the intergenerational and contextual aspects of health-related selection to education (Jackson 2015). The theory considers the accumulation of inequality as a life course process that is shaped by family lineage, resource mobilization, human agency, and individual perceptions of life trajectories (Ferraro and Shippee 2009). Advantage and disadvantage are seen as positions in a social hierarchy, but it is held that they are not the exact opposites of each other: advantage is best characterized as exposure to opportunity, whereas disadvantage is exposure to risk (Ferraro and Shippee 2009). Applied to poor early health, the presence of health problems forces a child to undergo a completely different set of social processes than would have been the case in the absence of health problems. For children in particular, health becomes an issue of concern only when it is threatened.

There are children with health problems in all kinds of families with different material, cultural, and social resources. The concept of *resource mobilization* highlights the potential of compensatory resources in buffering against the harmful consequences of early disadvantage (Parcel, Dufur, and Cornell Zito 2010). Parents who are highly educated and enjoy high wages may be able to compensate for the educational risks posed by early health problems by supporting their child both intellectually and financially. Highly educated parents spend time with their children more actively (Craig 2006; Guryan, Hurst, and Kearney 2008), and by doing so, they may be able to stimulate their children's cognitive development (Lundborg, Nilsson, and Rooth 2014; Noble et al. 2015). Although a less important aspect in the Nordic context, these parents may also be able to acquire the best possible treatment for their child and avoid long patient queues (Case and Paxson 2006).

By contrast, some children may experience simultaneous disadvantage in multiple domains of life. Following the cumulative inequality theory, the combined effect of cumulative disadvantage is not necessarily a simple unit count because certain combinations of disadvantage can be especially challenging and certain negative experiences may require other adversities to become truly consequential (Schafer, Ferraro, and Mustillo 2011). Thus, an analysis of cumulative inequality needs to address the potential nonlinearity in life course trajectories (Ferraro and Shippee 2009). In line with the theory, Jackson (2009) hypothesizes that health problems could pose a "double jeopardy" for adolescents who belong to an ethnic minority and/or whose parents have a low SEP. These adolescents are at a heightened risk of both experiencing multiple stressors (e.g., poverty, crime, and parental divorce) and lacking necessary compensatory resources (Jackson 2009). Their parents might lack the capability to administer the necessary medications and diet for their child having a chronic condition, such as asthma or diabetes (Case and Paxson 2006). Altogether, the realized educational risk could become even larger than the sum of its parts.

Although structural disadvantage poses risks for the persistence of inequality throughout the life course, the cumulative inequality theory leaves a lot of room for *human agency* to shape life trajectories (Ferraro and Shippee 2009). Individual perceptions of the past and expectations of the future could be important in explaining why certain individuals fare well despite starting their lives with an additional burden of disadvantage. A study examining the connections between early disadvantage and individual evaluations of the future discovered that individuals exposed to the highest amounts of childhood adversity also tend to expect the largest improvement in the future—possibly because they have more room to improve (Schafer et al. 2011). As an alternative to the "double jeopardy" hypothesis, Jackson (2009) proposed that the effect of health problems on educational careers may well be more negative among adolescents coming from an advantageous background. These adolescents are expected to reach a high level of education, but because of this, they also have further to fall. Their health problems could deprive them of their educational assets, whereas those coming from a disadvantaged background have little to lose to begin with (Jackson 2009). Correspondingly, only the advantaged might lower their educational expectations as a reaction to health problems.

The genetic and social *family lineage* could become intertwined with health-related selection to education in an even more complicated manner. Educational attainment is a social scientific variable that shows particularly strong intergenerational persistence—a correlation of 0.4, on average, globally (Hertz et al. 2007). According to a recent international twin study, 43% of variation in educational attainment between individuals is explained by genetic factors; however, environmental factors shared within a family also account for a substantial proportion, 31% (Silventoinen et al. 2020). Considering that there are notable socioeconomic disparities in early health

(Currie 2011; Reiss 2013; Viner et al. 2012), some authors have suggested that health-related selection to education could play an important role in explaining the parental contribution to offspring schooling, and, more generally, the intergenerational transmission of SEP (Case and Paxson 2006; Currie 2009; Palloni 2006). In line with this hypothesis, Basch (2011) uses the term "educationally relevant health disparities" to refer to the subgroup of childhood health conditions that both shows socioeconomic disparities and is potentially harmful for educational careers.

What is missed by these theoretical accounts of intergenerational transmission is that the significance of early health for intergenerational transmission could become further amplified if the above-mentioned "double jeopardy" hypothesis holds. In this scenario, health problems would, firstly, be more common among socially disadvantaged children and, secondly, their effects on education would also be stronger in this group. On the other hand, the reverse may be the case if health problems show a stronger effect among advantaged children and are especially significant in explaining downward social mobility. The importance of early health disparities as an explanation to the intergenerational persistence of SEP would then be smaller than expected. Connecting health selection to cumulative inequality makes a case for simultaneously examining the moderation of selection by parental socioeconomic resources and the mediation of the intergenerational transmission of education by health problems.

3 EMPIRICAL EVIDENCE ON HEALTH-RELATED SELECTION TO EDUCATION

This chapter reviews existing evidence on the association between child or adolescent health problems and educational outcomes. Cross-sectional and retrospective studies are mentioned only when they provide the sole available evidence regarding the question of interest. When reviewing studies that connect health-related selection to social origin, parental income and occupation are also taken into consideration, although the principal interest is in the role of parental education.

3.1 THE IMPACT OF DIFFERENT TYPES OF HEALTH PROBLEMS

A large part of previous research focuses on the educational consequences of birthweight and other proxies of healthy prenatal development. Studies comparing the birthweight of monozygotic twins or biological siblings show that low birthweight has, at the most, a weak association with lower educational attainment (Fletcher 2011; Jelenkovic et al. 2018; Miller, Mulvey, and Martin 2005). Although much of this research is negligent of health status in later childhood or adolescence, studies including measures of both infant health and later childhood health suggest that their contributions, if any, are largely independent of each other (Brekke 2015; Currie et al. 2010; Roos et al. 2013).

Self-rated health has been one of the most common indicators when studying the educational consequences of health at ages beyond infancy (Haas and Fosse 2008; Jackson 2009; Lê, Diez Roux, and Morgenstern 2013; Lynch and von Hippel 2016; Needham et al. 2004). Most of these studies report a meaningful association between self-rated health and educational attainment even when estimated within biological sibships differing in health status to control for familial confounding (Haas and Fosse 2008; Jackson 2009; Lê et al. 2013). Although this measure does not allow for the separation of different types of health problems, it has been useful in highlighting the overall importance of child and adolescent health in educational attainment. It can also be considered an advancement compared with the even older tradition of using height as a marker of childhood health (Case and Paxson 2010; Power, Manor, and Li 2002).

In studies informative of different types of health problems, three approaches to measurement can be identified: using combination indicators of somatic conditions or mental disorders (Evensen et al. 2016; Van Der Heide et al. 2016; Layte and McCrory 2013; Maslow et al. 2011; De Ridder et al. 2013; Roos et al. 2013; Smith 2009; Uiters et al. 2014); closely examining a single

health condition, such as type 1 diabetes or ADHD (Boman et al. 2010; Dahlquist and Källén 2007; Fletcher 2010; Fried et al. 2016; Needham 2009); and analyzing a few chosen health conditions within a single study (Champaloux and Young 2015; Forrest et al. 2013). Some of these studies include both combination indicators and individual health conditions, but surprisingly few studies have simultaneously examined the impact of different types of somatic conditions and mental disorders. Although some authors have access to data including individual health conditions, they are unable to analyze them individually because of a small sample size (Smith 2009). Based on studies that include measures of both somatic conditions and mental disorders, it seems that the average association of mental disorders with educational outcomes is stronger than that of somatic conditions (Layte and McCrory 2013; Roos et al. 2013; Uiters et al. 2014).

With regard to individual somatic conditions, there is a lot of variation in the associations reported in previous studies. Most evidence shows that asthma is not associated with lower school performance or educational attainment (Mazurek, Schleiff, and Henneberger 2012; Roos et al. 2013; Ross et al. 1992) although it seems to increase the number of missed school days (Moonie et al. 2006). By contrast, type 1 diabetes predicts impaired school performance and school dropout in some studies (Dahlquist and Källén 2007; Fletcher and Richards 2012; Persson et al. 2013), but not all studies report associations (Lloyd, Robinson, and Fuller 1992; Wennick et al. 2011). As for childhood cancer, the overall consensus seems to be that those recovering from the condition do not experience long-term educational harm, except for possibly in the case of leukemia and central nervous system tumors (Boman et al. 2010; Ghaderi et al. 2016; Koch et al. 2004; Kuehni et al. 2012; Lancashire et al. 2010). Inflammatory bowel disease (Mayberry et al. 1992; Singh et al. 2015) and rheumatoid arthritis (Foster et al. 2003) are unrelated to education in previous studies, but the evidence is mostly based on too-small samples to draw solid conclusions. Although the impact of epilepsy on cognition has been examined in previous studies (Hermann and Seidenberg 2007), there is little evidence of its impact on educational attainment.

Conduct disorder, ADHD, substance misuse, and psychotic disorders have typically been associated with the largest reductions in educational attainment in studies examining the impact of individual psychiatric and neurodevelopmental conditions (Breslau et al. 2008; Evensen et al. 2016; Fried et al. 2016; Frissen et al. 2015; Goulding, Chien, and Compton 2010; Isohanni et al. 2001; S. L. Johnson et al. 1999; Kessler et al. 1995; McLeod and Kaiser 2004; McLeod et al. 2012; Miech et al. 1999). Evidence on the contribution of disorders belonging to the "internalizing" spectrum, such as depression and anxiety, is more inconclusive. Some studies do not observe an association, especially when adjusting for familial confounders (Breslau et al. 2008; Fergusson and Woodward 2002; J. G. Johnson et al. 1999; Miech et al. 1999), whereas Fletcher (2010) shows depression to predict a large increase in high school dropout even in sibling comparisons. Moreover, some earlier

research implies that the association between internalizing spectrum disorders and educational outcomes is fully explained by comorbid externalizing spectrum disorders, such as conduct disorders, ADHD, and substance misuse (Breslau et al. 2011; Evensen et al. 2016; Fergusson and Woodward 2002).

3.2 THE DIFFERENT STAGES OF SELECTION

Regardless of what types of health problems are included, most previous studies examine the completion of upper-secondary education, i.e., high school or other education covering phase three in the International Standard Classification of Education, typically completed at approximately ages 16–19 (Fried et al. 2016; Van Heesch et al. 2012; Van Der Heide et al. 2016; Maslow et al. 2011; De Ridder et al. 2012; Stoep et al. 2003). In addition, a large part of previous research measures the timely completion of upper-secondary education (Breslau et al. 2011; Haas and Fosse 2008; Jackson 2009) rather than the ultimate completion probably because of the weak availability of datasets combining the measurement of early health problems with a long follow-up of educational attainment. On the other hand, the primacy of upper-secondary completion is justified by the fact that in most education systems it signifies the end of compulsory schooling and divides individuals into alternative educational pathways (OECD 2018:182).

Few previous studies have been able to provide information on the impact of health problems on postsecondary educational outcomes. When studies have included postsecondary outcomes, they have mainly examined enrollment in tertiary education among the subgroup of young people who have previously attained a relevant upper-secondary degree (Evensen et al. 2016; Fletcher 2010; Haas and Fosse 2008; Jackson 2009; McLeod and Kaiser 2004; Needham 2009). Some of these investigations report that the association of poor self-rated health or depression with immediate postsecondary enrollment is either fully or mostly explained by the prior completion of secondary education (Fletcher 2010; Haas and Fosse 2008), whereas some studies on mental disorders report meaningful associations above and beyond the completion of upper-secondary education (Evensen et al. 2016; McLeod and Kaiser 2004; Needham 2009). As one of the few previous investigations to evaluate the completion of tertiary education, a previous study from Finland observed early-onset psychiatric disorders (onset before age 22) to predict a lower likelihood of both completing a secondary education and completing a tertiary education by age 31 (Isohanni et al. 2001).

Many studies report that early health problems have a negative impact on test scores or grades received at school (Crump et al. 2013; Dahlquist and Källén 2007; Ding et al. 2009; Fletcher and Wolfe 2008). Although the ability to learn new skills and perform well at school is important for future educational opportunities, these studies cannot be used to draw conclusions

on the contribution of impaired school performance to the association between health problems and lower educational attainment. A small group of previous studies has conducted formal mediation analysis to examine the role of school performance as a mediator of health–schooling relationships (Jackson 2009; Låftman and Magnusson 2017; McLeod et al. 2012; Sagatun et al. 2014). Jackson (2009) observed that weakened school performance accounted for most of the impact of self-rated health on high school completion and roughly half of its impact on college attendance. In other mediation studies, impaired school performance explains at least half of the association between mental disorders and educational attainment (Låftman and Magnusson 2017; McLeod et al. 2012; Sagatun et al. 2014).

Horizontal stratification—the allocation of individuals into separate tracks within the same educational level—is a typical subject of study in the sociology of education (Gerber and Cheung 2008), but previous health selection research has mostly examined vertical stratification. In the case of health problems, the question of horizontal stratification is particularly interesting because physically limiting health problems could also push a person toward pursuing a more academically oriented educational career (Teachman 2012). Sagatun et al. (2014) showed that externalizing and internalizing problems are equally predictive of dropout in the general and vocational track of upper-secondary education in Norway. However, it remains unclear whether adolescents with and without health problems have an equal likelihood of choosing and completing these tracks. Based on results obtained in disability studies, adolescents with disabilities have lower university expectations (Chatzitheochari and Platt 2019) and are less likely to complete college preparatory coursework (Shifrer, Callahan, and Muller 2013). Chatzitheochari and Platt (2019) even show that past school performance explains 39% of the reduction in university expectations.

3.3 SOCIAL ORIGIN AND HEALTH-RELATED SELECTION TO EDUCATION

The background chapter introduced two ways in which social origin could be connected to health-related selection to education: the moderation of selection by parental socioeconomic resources and the mediation of the intergenerational transmission of education by health problems. A handful of previous studies examine the heterogeneity of health–schooling relationships between families of different SEP. In support of the resource mobilization and "double jeopardy" hypotheses, Jackson (2015) discovered that the association between childhood health conditions and test scores is weaker in families with high social capital. In contrast, Flouri (2007) and an earlier study by Jackson (2009) found support for the opposite hypothesis by showing that early hyperactivity and poor self-rated health, respectively, are more consequential for socially advantaged children. Complicating the picture further, Evensen

(2016) did not observe differences in the association between mental disorders and educational attainment according to parental education.

Previous studies on the intergenerational transmission of education or other aspects of SEP have rarely assessed the significance of health problems as a mediator of the association. A study including data from the United States and Norway showed that self-rated health in adolescence mediates less than 5% of the relationship between socioeconomic background and high school completion (Sznitman, Reisel, and Khurana 2017). Based on two previous studies, the contribution of prenatal health to the intergenerational transmission of SEP is equally small (Carvalho 2012; Härkönen et al. 2012). On the other hand, a study examining intergenerational mobility implied that poor self-rated health and health-related school absences clearly increase the likelihood of downward mobility in the social hierarchy and decrease the likelihood of upward mobility (Manor, Matthews, and Power 2003); similar results have been observed for taller height as a proxy of health (Blane, Smith, and Hart 2007; Cernerud 1995; Power et al. 2002). In some studies, early health did not contribute to the intergenerational associations, which could be explained by the absence of early socioeconomic disparities in health or the absence of health-related selection to SEPs (Hoffmann et al. 2018; Novak, Ahlgren, and Hammarstrom 2012).

3.4 IDENTIFIED GAPS IN THE LITERATURE

Overall, most previous research on the association between early health and educational outcomes focuses on prenatal health, proxies of health status, or self-rated health. There is a shortage of research comparing the impact of different types of health problems observed in childhood or adolescence. Even in studies providing information on different types of health conditions, the measurement is usually based on self-reports (Forrest et al. 2013), often collected retrospectively from adults (Breslau et al. 2008). The small sample sizes of previously available datasets have prevented many studies from examining the associations of individual conditions (Smith 2009) or forced them to combine certain conditions for practical rather than theoretical reasons (Champaloux and Young 2015). These observations are supported by a host of systematic reviews published during the past decade (Eide and Showalter 2011; Esch et al. 2014; Hale et al. 2015; Melkevik et al. 2016; Suhrcke and de Paz Nieves 2011). The reviews also note that the overrepresentation of studies coming from the United States undermines the generalizability of existing evidence (Hale et al. 2015; Suhrcke and de Paz Nieves 2011).

Few previous studies have access to a long enough follow-up to evaluate the completion of tertiary education. Even in the analysis of upper-secondary outcomes, the follow-ups are usually too short to distinguish between delayed and permanently discontinued educational careers. Moreover, the analyses of

health-related differences in school performance have rarely proceeded a step further to examine the contribution of these differences to the association between early health problems and educational attainment. Similarly, although horizontal stratification is often featured in the sociology of education, it has received virtually no attention in previous health selection research.

A large group of previous studies has been able to complement their adjusted analyses with sibling fixed-effects models to eradicate all confounding shared within sibships (Currie et al. 2010; Fletcher 2010; Fletcher and Wolfe 2008; Haas and Fosse 2008; Lê et al. 2013; De Ridder et al. 2013). However, the accurate analysis of within-sibship variation in health problems requires an especially large sample size (Frisell 2020), and many of these studies suffer from broad confidence intervals. This becomes particularly clear in studies attempting to use sibling fixed-effects models to examine the moderation of health-related selection to education by socioeconomic background (Evensen et al. 2016; Jackson 2009). Overall, current evidence on the intergenerational aspects of the association between early health and educational outcomes is mixed and mostly based on self-reported health measures, possibly underestimating the role of severe conditions.

4 THE AIMS OF THE STUDY

The present thesis broadens our understanding of health-related selection to education in several important ways. The work divides into three sub-studies, each of which addresses a specific set of questions that have received little attention in previous studies. At the same time, all sub-studies share the common goal of using data on medical diagnoses and treatment (instead of self-rated health) to examine the role of different types of health problems (instead of a single health condition) in adolescence (instead of at birth or in early childhood) as determinants of educational outcomes in a Nordic welfare state (instead of the United States).

Although self-rated health has been shown to be predictive of "objective" health outcomes (Idler and Benyamini 1997), information on the effects of different types of health problems is arguably more useful when targeting preventive efforts. The present investigation pays particular attention to the division between somatic conditions and mental disorders, featured in a slightly different format in all three sub-studies. When the effects of different types of health problems are assessed in the same study (i.e., using the same data and study design), comparing their relative contribution to educational outcomes becomes more valid. All sub-studies measure health problems in early adolescence (at ages 10–16), thus capturing a potential sensitive period involving the last years of compulsory schooling close to application to upper-secondary education. For the present study, the important question is which conditions are either severe or long-term enough to potentially cause disruptions in educational careers.

Sub-study I identifies the associations between a wide range of health conditions and dropout from upper-secondary education. The term "dropout" is used to refer to the combination of non-participation and non-completion measured at ages 17 and 21, with the idea of capturing both immediate (age 17) and more persistent (age 21) associations of health problems. As one of its central aims, the study seeks to provide an overall picture of health selection by simultaneously focusing on 3 combination groups of health problems (somatic conditions, mental disorders, and injuries) and 25 specific health conditions. The impact of health problems is assessed based on two complementary perspectives: by comparing relative risks of dropout between adolescents with and without health problems and by examining the population-level contribution of health problems to dropout with population-attributable fractions. The study also examines the significance of sex differences and comorbidity for the associations.

Sub-study II delves into the mechanisms of selection by identifying the contribution of weakened school performance (measured by grade point average at the end of compulsory schooling) to health-related differences in upper-secondary educational outcomes. In addition to analyzing failure to

complete upper-secondary education by age 23, the study introduces a novel perspective on selection by examining the effect of health problems on upper-secondary track choice (general vs. vocational). The analysis takes advantage of the counterfactual mediation framework to decompose the total effect of health problems into direct and indirect components. Health-related selection to education is assessed with regard to broad groups of somatic conditions and mental disorders as well as four more specifically defined groups of health conditions. The study is also able to conduct the same decompositions within sibships to adjust for all observed and unobserved confounders shared by biological siblings.

Sub-study III examines the connections between social origin and health selection. Educational attainment is followed until age 27, which enables the separate analysis of selection to secondary and tertiary education. The latter is only analyzed among young adults with completed secondary education—a prerequisite for entering tertiary education. However, even among those who complete secondary education, the decision to continue to tertiary education is often foreshadowed by the choice between a general and a vocational track in upper-secondary education. To examine whether selection to tertiary education operates, to some extent, independent of secondary education, an additional analysis adjusts for upper-secondary track choice. The presence of adolescent health problems is assessed with three groups that aim to capture different aspects of health: chronic somatic conditions, frequent infections, and mental disorders.

The role of social origin is examined from two interrelated perspectives: the moderation of health selection by parental education and the mediation of the intergenerational transmission of education by health problems. As for the moderation analysis, the idea is to investigate whether health-related selection to education applies equally to everyone regardless of parental education. As noted in the literature review, there are reasons to expect that the associations could be weaker in families with high parental education, but the reverse may well be the case. Both the main effect and moderation analyses are strengthened with sibling comparisons. The analysis on the intergenerational transmission of education rests on the assumption that (1) high parental education is inversely associated with adolescent health problems and (2) adolescent health problems are in turn associated with lower educational attainment. While the latter assumption is at the core of the present thesis, the former association is adjusted for in the other sub-studies. Figure 1 illustrates the causal assumptions of the thesis.

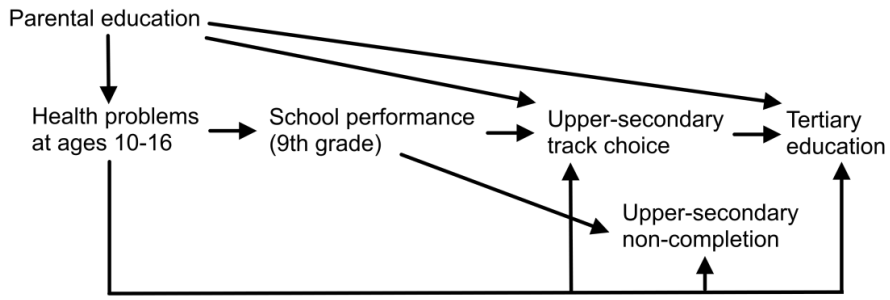

Figure 1 A simplified causal framework summarizing the associations examined in sub-studies I–III. Interactions and confounders (see Methods section) have been omitted for clarity.

5 THE FINNISH CONTEXT

In many ways, the Finnish education system provides an extraordinary setting for studying the basic processes of health-related selection to education. Most importantly, education is tuition-free at all levels, which ensures that the connections between health and educational opportunity are more likely caused by social, psychological, or cognitive factors rather than a necessity to decide between healthcare costs and tuition fees. This benefit is made even clearer by the fact that pediatric healthcare is highly subsidized in Finland. Another important aspect of the Finnish education system for health-related selection is that there are no official dead-ends: regardless of the study track of the previously attained degree, it is always possible to apply for further education (Pekkarinen, Uusitalo, and Kerr 2009). This guarantees that failures and misguided decisions in the past do not automatically restrict one's educational opportunities in the future.

Figure 2 outlines the Finnish education system. With negligible exceptions, all cohorts included in the analyses of this dissertation have gone through the same system. Compulsory basic education lasts nine years and is provided by comprehensive schools. Finnish pupils usually complete their compulsory schooling in 9 years between ages 7 and 16, although some pupils may opt for an additional tenth year to improve their grades (OECD 2013). Comprehensive schools are allowed to provide weighted-curriculum education in certain subjects, but in general the Finnish basic education contains little achievement-based tracking (OECD 2013). More than 99% of Finnish pupils receive a school-leaving certificate within 10 years from the start of their educational career (Finnish National Agency for Education 2020b).

After completing compulsory schooling, adolescents may apply for upper-secondary education, which divides into a general track and a vocational track (or rarely, a combination of these), both lasting three years on average. A corresponding division between academically oriented and vocational programs can be found in many countries (OECD 2018:182). Acceptance to the preferred study program is predominantly determined by grade point average at the end of compulsory schooling, comprising theoretical subjects when applying to a general track and all subjects when applying for a vocational track. Although both tracks grant eligibility to apply for all types of tertiary education (Pekkarinen et al. 2009), general upper-secondary education is more academically oriented, whereas vocational programs prepare individuals to work in manual and lower non-manual jobs. Tertiary education is provided by academic universities and universities of applied sciences, acceptance to which is mainly based on the matriculation examination (the final examination in general upper-secondary schools) or a field-specific entrance examination (Ministry of Education and Culture 2020).

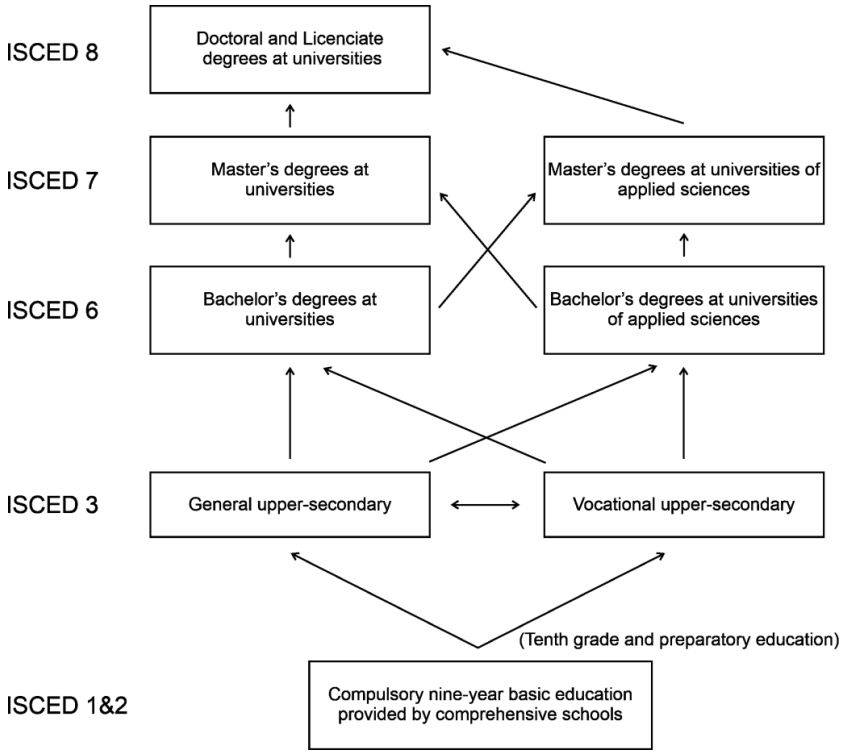

Figure 2 An overview of the Finnish education system based on the International Standard Classification of Education, ISCED 2011. Source: Ministry of Education and Culture (2020).

The completion of upper-secondary education receives particular attention in this dissertation because it is undoubtedly the most consequential of all post-compulsory educational outcomes. Adolescents who do not attain any upper-secondary degree are especially likely to experience unemployment and poverty and to engage in criminal offending (Maynard, Salas-Wright, and Vaughn 2015; OECD 2012). The percentage of young people aged 17–24 who did not participate in upper-secondary education decreased from 16.5% among men and 11.9% among women in 1995 to 9.3% and 6.4%, respectively, in 2018 (Figure 3). However, if we examine the percent of young adults aged 25–29 who had not completed any upper-secondary degree in the same time period, it seems that a large proportion of the new participants to upper-secondary education failed to complete their studies.

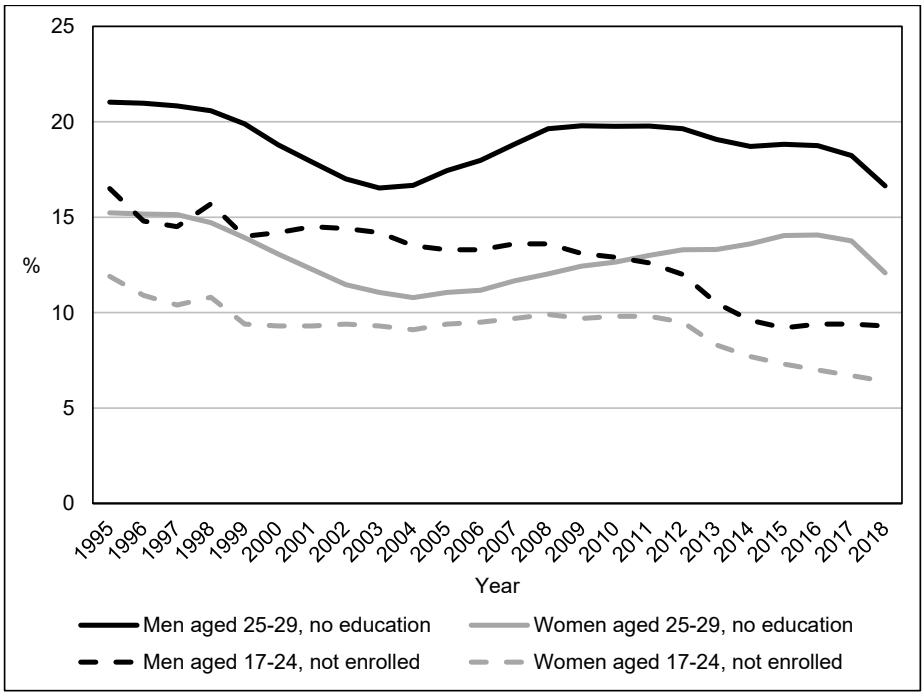

Figure 3 The proportion of Finnish men and women aged 25–29 without upper-secondary education in 1995–2018 as well as the proportion of men and women aged 17–24 not enrolled in upper-secondary education and not having an upper-secondary degree in the same period. Sources: Statistics Finland (2020a) and the National Institute for Health and Welfare (2020).

During the past decade, the relative popularity of general and vocational upper-secondary education has fluctuated between 45% and 55% (Finnish National Agency for Education 2020b). Despite the lack of formal connections between upper-secondary and tertiary degrees, upper-secondary track choice is strongly predictive of decisions to pursue tertiary education. Among first-time students in academic universities, roughly nine out of ten have completed the general track in upper-secondary education. In the more practically oriented universities of applied sciences, the proportion is still nearly six out of ten among students without an earlier tertiary degree (Finnish National Agency for Education 2020b). Besides analyzing the effect of health problems on the completion of upper-secondary education, the present thesis seeks to achieve a more nuanced picture of health selection by examining upper-secondary track choice and selection to tertiary education as separate phenomena.

6 DATA AND METHODS

6.1 DATA AND STUDY POPULATION

The three sub-studies included in this dissertation used data derived from Finnish administrative registers. All Finnish residents have a personal identification number, which can be used to link information between different registers. For research purposes, Statistics Finland extracts the required information and replaces personal identification numbers with artificial identifiers. The data files were accessed through a remote-access system. Statistics Finland approved the use of register data in the present study (permission number TK-53-525-11).

In practice, the sub-studies were based on two different versions of the same dataset. The study populations of sub-studies I and II were derived from a 20% random sample of Finnish households with children aged 0–14 at the end of 2000, whereas by the time of sub-study III, total population data on all Finnish children aged 0–14 in 2000 had become available. In both cases, the data included all biological mothers and fathers who could be linked to their children with parental identification numbers. The question of which birth cohorts could be included in the analyses was largely dictated by the availability of education follow-up, gradually increasing from the year 2012 to the year 2018 during the study process. Altogether, the analyses covered individuals born in 1986–1995, but each sub-study included a slightly different set of birth cohorts (see Table 1 for a summary of study characteristics).

Besides the selection of birth cohorts, some exclusions were made to the original sample to support the validity of statistical inference. First, all sub-studies focused only on children living in mainland Finland, thus excluding those who dwelled in the Åland islands. This was because Åland islanders commonly pursue secondary and tertiary education in Sweden. Second, all sub-studies excluded children with intellectual disabilities because these individuals are often engaged in alternative forms of schooling and workshops that do not grant a regular upper-secondary or tertiary degree. Third, the analyses excluded persons who did not live in Finland in the key measurement years, i.e., the years of age at which health problems (ages 10–16) and educational outcomes (see Table 1) were measured. Fourth, sub-studies II and III restricted their analyses to children who lived with at least one parent at ages 10–14 to measure family sociodemographic and socioeconomic factors more accurately. Finally, to identify biological siblings for the sibling fixed-effects models, both biological parents had to be available in the registers.

Table 1. *Characteristics of sub-studies I–III*

	Sub-study I	**Sub-study II**	**Sub-study III**
Birth cohorts	1988–1995	1988–1993	1986–1991
Educational outcomes	Dropout from upper-secondary education: not enrolled, not completed	Upper-secondary non-completion and track choice	The completion of secondary and tertiary education
Outcomes measured at age	17 and 21	23	27
Health problems	Broad groups of somatic conditions, mental disorders, and injuries; 25 specific health conditions	Broad groups of somatic conditions and mental disorders; complex chronic conditions, internalizing (depression or anxiety), and externalizing (ADHD or conduct disorder)	Groups of chronic somatic conditions (n = 10), frequent infections, and mental disorders
Health problems measured at age	10–16	10–16	10–16
Health problems measured based on	Inpatient and outpatient specialized care	Inpatient and outpatient specialized care	Inpatient and outpatient specialized care, special reimbursement rights for long-term medication, and purchases of antimicrobial drugs
Mediators		Grade point average	Health problems
Interactions	Between sex and health problems	Between school performance and health problems	Between parental education and health problems
Methods	Poisson regression with robust standard errors, population-attributable fractions	G-computation based on logistic regression models with and without sibling fixed effects	Linear probability models with and without sibling fixed effects, g-computation based on logistic regression models
N	101,284 at age 17 and 50,327 at age 21	73,072 for non-completion and 62,462 for track choice; 35,892 and 31,921, respectively, in sibling comparisons	352,899 for secondary education and 263,239 for tertiary education; 163,430 and 138,852, respectively, in sibling comparisons

6.2 EDUCATIONAL OUTCOMES

Statistics Finland provided annual data on completed degrees and enrollment in educational institutions. Sub-study I used these data sources in concert to form an indicator of dropout from upper-secondary at ages 17 and 21. Sub-study II used data on attained degrees to measure the completion of upper-secondary education by age 23 in general and the completion of the vocational track (instead of the general track) in particular. Sub-study III formed two dummy variables to measure the completion of upper-secondary and tertiary education by age 27. In a sensitivity analysis, data on enrollment was used as a proxy for future degrees.

Sub-study II measured school performance based on grade point average at the end of compulsory schooling (most typically at age 16), derived from the Joint Application Register of the Finnish National Board of Education. Grade point average is the arithmetic mean of 11–13 theoretical subjects (i.e., artistic and practical subjects are not considered), graded with integers ranging from 4 to 10. It is recorded in the register at the precision of two decimals. All teachers are expected to follow the same national grading guidelines, but the lack of standardized tests leaves some room for teacher- and school-level variation in grading practices. Additionally, sub-study II used data from the application register to form an alternative, more direct indicator for track choice: choosing the vocational track as the first preference when applying to upper-secondary education for the first time.

6.3 HEALTH PROBLEMS

The definition of early-adolescent "health problems" or "health conditions" was one of the recurring challenges throughout the research process. At an early stage it became obvious that no ready-made solution was available because adolescence is in general characterized by a low prevalence of severe health conditions. What is more, the availability of diagnosis-level data involved almost endless possibilities compared with the majority of previous studies relying on widely used survey datasets, such as the NLSY97 in the United States (Jackson 2009). Consequently, all three sub-studies used a slightly different definition and classification of health problems, which was beneficial in evaluating the generalizability of the results across definitions. All sub-studies measured the presence of health conditions at ages 10–16.

Sub-study I used nationally representative data on visits to inpatient and outpatient care, delivered by the National Institute for Health and Welfare. The data included primary ICD-10 (International Statistical Classification of Diseases and Related Health Problems, 10th edition) diagnoses that were used to identify broad groups of somatic conditions (A00–E89, G00–N99, P00–Q99), mental disorders (F10–F69, F80–F99), and injuries (S00–S99, T00–T14). Within these broad categories, the study further identified 25 specific

health conditions that were commonly featured either in previous health selection research (e.g., asthma, type 1 diabetes, and ADHD) or the pediatric literature on cognitive outcomes or quality of life (e.g., epilepsy, eating disorders, and intracranial injury).

The main analyses of sub-study II were based on broad groups of somatic conditions (A00–E89, G00–N99, Q99) and mental disorders (F10–F69, F90–F99), identified using inpatient and outpatient data. With the purpose of capturing more severe somatic conditions on average, the study also included two alternative definitions: the reception of treatment for somatic conditions in 4+ years at ages 10–16 and the presence of diagnoses categorized as *pediatric complex chronic conditions* (Feudtner et al. 2014). To examine the relative weight of externalizing and internalizing spectrum mental disorders, the study included combined groups of ADHD and conduct disorders (externalizing), as well as depression and anxiety (internalizing). These groups were mutually adjusted for each other in the analyses.

Sub-study III used a stricter definition of somatic conditions than the other two sub-studies. With the specific purpose of identifying educationally relevant health conditions for the moderation and mediation analyses, a group of chronic somatic conditions was defined based on 10 conditions that have been associated with educational outcomes in previous studies: type 1 diabetes, epilepsy, cancer, dorsopathy/spinal disease, migraine and other headache syndromes, congenital heart disease, atopic dermatitis, visual or hearing impairment, rheumatoid arthritis, and obesity. In contrast, the group of mental disorders corresponded to the one used in sub-study II. In addition to data on inpatient and outpatient care, sub-study III identified chronic health conditions using data on special reimbursement rights for long-term medication to supplement the groups of somatic conditions (type 1 diabetes, epilepsy, rheumatoid arthritis, and cancer) and mental disorders (psychosis) where relevant. The reimbursement rights are issued by specialist doctors and collected to a national register upheld by the Finnish Social Insurance Institution. Additionally, sub-study III included an indicator of frequent infections to reflect long-term illness burden that could remain unnoticed in specialized care data. Here, data on prescription drug purchases, delivered by the Finnish Social Insurance Institution, were used to identify the number of antimicrobial drug purchases at ages 10–16. Having at least seven purchases (one per year on average) was considered an indicator of frequent infections.

6.4 ADDITIONAL COVARIATES

All sub-studies adjusted for sex, birth year, maternal age at birth, and sibship size. The sub-studies also included slightly different sets of additional control variables, dictated by the study design and the availability of data. To stabilize annual fluctuations, living conditions and socioeconomic factors were measured as means or modes at ages 10–15 in sub-study I and at ages 10–14

in sub-studies II and III. All control variables were derived from the population registers of Statistics Finland.

The additional control variables of sub-study I included birth quarter (derived from birth month), immigrant status (native-born/second generation/first generation), household income quintile (adjusted for consumption units), highest parental education (basic/secondary/lower tertiary/higher tertiary), family type (two parents/single parent/other), persons per room (1–2/2 or more/unknown), region of residence (Capital region + European Union NUTS 2 region), and type of municipality (urban/semi-urban/rural).

Sub-study II additionally adjusted for mother tongue (Finnish/Swedish/other), country of birth (Finland/other), family type (two parents/single parent), highest parental education (higher tertiary/lower tertiary/short-cycle tertiary/upper secondary/basic), household disposable income, region of residence (18 regions), and geographical urban–rural classification (inner-urban/outer urban/peri-urban/local centers in rural areas/rural areas close to urban/rural heartland/sparsely populated rural).

Sub-study III controlled for mother tongue (as in sub-study II), family type (two parents/mother only/father only), the highest level of education among biological parents (tertiary/secondary/basic), region of residence (18 regions), and urban rural classification (as in sub-study II). The same indicator of parental education was used in the analyses on moderation by parental education and the intergenerational transmission of educational attainment.

6.5 STATISTICAL ANALYSIS

6.5.1 POISSON REGRESSION AND POPULATION-ATTRIBUTABLE FRACTIONS

Sub-study I used the so-called modified Poisson regression model to estimate the risk ratios (RR) of dropout according to the presence of health problems. The preferred approach to estimating risk ratios, the log-binomial model, is known for its convergence issues (Yelland, Salter, and Ryan 2011). However, it has been shown that the Poisson regression model produces similar results for binary outcomes when the model is "modified" with robust standard errors (Zou 2004). Risk ratios were preferred over odds ratios both because they are more intuitive to interpret and because they are collapsible, i.e., their magnitude does not change with the inclusion of covariates unrelated to the exposure (Sjölander, Dahlqwist, and Zetterqvist 2016).

In the second phase of sub-study I, the crude and adjusted risk ratios were processed further into population-attributable fractions (PAF). The calculation of PAFs takes into account the prevalence of health conditions to evaluate the percentage reduction in dropout following the elimination of a

given health condition. As noted by Rockhill, Newman, and Weinberg (1998), different formulas should be used when calculating crude and adjusted PAFs:

(1) $$\text{Crude PAF} = P_T(RR_C - 1)/(1 + P_T(RR_C - 1))$$

where P_T is the overall prevalence of the health condition and RR_C is the crude risk ratio;

(2) $$\text{Adjusted PAF} = P_D((RR_A - 1)/RR_A)$$

where P_D is the prevalence of the health conditions among adolescents dropping out and RR_A is the adjusted risk ratio.

6.5.2 COUNTERFACTUAL-BASED MEDIATION ANALYSIS

Sub-study II took advantage of the counterfactual/causal mediation framework, which is based on the idea of potential outcomes. When causal inference is viewed through the lens of potential outcomes, it becomes a missing data problem because we can observe only one potential outcome for each person (Rubin 2004). For instance, we do not know what the educational attainment of persons with health problems would have been had these persons not encountered health problems, and vice versa. Along the same lines, we cannot observe the impact of a mediator (here, school performance) on the outcome (upper-secondary education) isolated from the exposure status (the presence of health problems). In a nutshell, the counterfactual approach to mediation analysis involves the imputation of missing potential outcomes and the calculation of population-averaged direct and indirect effects using these outcomes (Wang and Arah 2015). Note that the word "effect" is used to refer to the ideal outcome of estimation, assuming that all relevant confounders have been adjusted for.

Following the definitions of VanderWeele (2013), we decomposed the *total effect* of health problems into three components: *pure direct effect* (part unexplained by school performance), *pure indirect effect* (health problems reduce school performance, which results in expectedly large changes in non-completion / track choice), and *mediated interaction effect* (health problems reduce school performance, resulting in larger or smaller than expected changes in non-completion / track choice). Pure indirect effect and mediated interaction effect together summarize the indirect effect of health problems on upper-secondary educational outcomes via school performance (VanderWeele 2013). The population-averaged effects are defined as follows:

(3) $$\text{Total effect} = E[Y_{xMx} - Y_{x*Mx*}],$$

(4) $$\text{Pure direct effect} = E[Y_{xMx*} - Y_{x*Mx*}],$$

(5) Pure indirect effect = $E[Y_{xMx} - Y_{xMx*}]$,

(6) Mediated interaction effect = $E[Y_{xMx} - Y_{xMx*} - Y_{x*Mx} + Y_{x*Mx*}]$,

where x refers to the presence of health problems and x* to their absence; Y is the educational outcome; and M is school performance.

To provide an alternative picture of the part of selection unexplained by school performance, we also calculated *controlled direct effects*, in a hypothetical intervention of fixing school performance at the 75th and 90th percentiles of the original distribution for everyone (Wang and Arah 2015). Controlled direct effects are defined by

(7) Controlled direct effect = $E[Y_{xm} - Y_{x*m}]$,

where m is the fixed mediator value.

There are several ways to estimate the effects suggested by the counterfactual mediation framework. Sub-study II used the parametric g-computation algorithm, which has been shown to produce more stable estimates and smaller standard errors than the alternative weighting-based approaches (Vansteelandt, Bekaert, and Lange 2012). Compared with other methods popular in social sciences (e.g., Baron and Kenny's method and the Karlson–Holm–Breen method), the counterfactual mediation framework allows for the explicit estimation of exposure–mediator interactions (Wang and Arah 2015).

In the first step of the g-computation procedure, we fitted an ordinary least squares model for the mediator (school performance) and a logistic regression model for the outcome (non-completion / choosing the vocational track). Both models included a health problem indicator and all confounders as covariates; the outcome model also included school performance. In the second step, the mediator model was used to simulate two potential levels of school performance for each person in the sample: school performance in the absence of health problems and in the presence of health problems. When calculating controlled direct effects, the mediator values were simply set by hand at the desired level for everyone. In the third phase, the potential values of the mediator and the parameters of the outcome model were used to predict the desired potential outcomes. Finally, these potential outcomes were used to calculate the effects of interest, outlined above, and bootstrapping was used for obtaining confidence intervals.

Based on within-sibship variation in health problems and school performance, the same procedure was also run using sibling fixed-effects models to adjust for all confounding shared by biological siblings (Frisell 2020). The sibling fixed-effects linear probability models were specified as follows:

$$(8) \qquad Y_{if} = \beta \times \text{health problem}_{if} + \mathbf{Z}_{if}\delta + \theta_f + \varepsilon_{if}$$

where *f* refers to families and *i* to individuals within families; **Z** represents individual-level confounders that vary between siblings (sex in sub-study II); and θ_f is a set of sibling group indicators. Linear probability models allowed the direct extraction of family-level intercepts used in the prediction step. The g-computation procedure is described more thoroughly in the article.

6.5.3 LINEAR PROBABILITY MODELS AND MEDIATION DECOMPOSITIONS

Sub-study III used linear probability models to estimate both the basic associations between health problems and educational outcomes and the interactions between parental education and health problems. Linear probability models were chosen because they allow for the direct estimation of interactions in the additive probability scale, which has a more natural interpretation than the multiplicative scale: a non-zero interaction term shows that the combined effect of parental education and health problems is either smaller or larger than the additive effect of the two factors (VanderWeele and Knol 2014). In sub-study III, the additive interactions were interpreted as evidence of moderation by parental education because parental education temporally preceded both health problems and offspring education. The models for secondary education included the whole study population, whereas the models for tertiary education included the sub-population who had attained secondary education. In addition to the conventional adjustment for confounders, the study used sibling fixed-effects linear probability models (adjusted for birth year and sex) to eradicate all shared familial confounding (see the formula above). The models for tertiary education were also re-estimated by adjusting for upper-secondary track choice to evaluate the contribution of earlier selection processes to the completion of tertiary education.

To estimate the contribution of health problems to the intergenerational transmission of education, sub-study III conducted a highly similar g-computation procedure as the one used in sub-study II for controlled direct effects. The procedure began with the estimation of a logistic regression model for the completion of secondary/tertiary education with parental education, all health problem indicators, and all confounders included as covariates. However, this time the model parameters were first used to predict a so-called natural course scenario, which was effectively a model-based reproduction of the real-world average probabilities of completing a secondary/tertiary education according to parental education (Bijlsma et al. 2019). The differences in the average probabilities showed the *total effect* of parental education. In the next step, all health problem indicators were set to zero for everyone to predict a counterfactual scenario where early-adolescent health problems were, hypothetically, eradicated. The remaining differences showed

the *controlled direct effect* of parental education, whereas the difference between the total effect and the controlled direct effect indicated the *portion eliminated* by the hypothetical eradication of early-adolescent health problems.

7 RESULTS

7.1 DROPOUT FROM UPPER-SECONDARY EDUCATION

Sub-study I examined the total contribution of different types of early-adolescent somatic conditions, mental disorders, and injuries—both broader groups and specific health conditions—to dropout from upper-secondary education. Table 2 presents the adjusted risk ratios (RR) of dropout at age 21 in relation to the broad categories of health conditions as well as the chosen specific health conditions. A similar analysis was conducted with regard to dropout status at age 17 to examine the contribution of health problems to delays in educational careers. At both ages, the groups of any condition, somatic conditions, mental disorders, and injuries were meaningfully associated with dropout even when adjusted for a large number of sociodemographic and socioeconomic confounders. The RRs related to somatic conditions and mental disorders were larger in the short term (age 17) than in the long term (age 21).

Only some specific somatic conditions were associated with dropout. Epilepsy, congenital heart disease, and severe infection strongly increased the risk of dropout at both ages, whereas asthma, type 1 diabetes, and rheumatoid arthritis made little difference. Cancer and visual or hearing impairment were highly predictive of dropout status at age 17 but were no longer predictive at age 21. Different types of mental and neurodevelopmental disorders were consistently associated with dropout throughout their spectrum. Psychosis and pervasive developmental disorder showed the greatest RRs, but their prevalence was also the lowest of all conditions. As for injuries, there was evidence of increasing risks with increasing severity (fractures vs. intracranial injuries).

Table 2 also showcases PAFs, which can be used to evaluate the population-level contribution of different types of health conditions to dropout from upper-secondary education. The adjusted PAF related to having any health condition at ages 10–16 was about 21%, whereas mental disorders alone accounted for 11% of dropout at age 21. The PAFs also elucidated the fact that although severe mental disorders, such as psychosis, show large RRs with dropout, their population-level contribution is likely to remain limited because of their rarity.

Table 2. *Adjusted (for sex and control variables) risk ratios[a] (RR with 95% confidence intervals, CI) and population-attributable fractions (PAF) of dropout from upper-secondary education at age 21 by the presence of health conditions[b] at ages 10–16 (n=50,327)[c]*

	Prevalence (%)	Adjusted RR	95% CI	Adjusted PAF
Any condition	56.85	**1.46**	(1.37-1.54)	21.41
Somatic conditions	35.56	**1.15**	(1.09-1.22)	5.34
Asthma	4.74	1.02	(0.91-1.16)	0.13
Allergy	3.23	0.91	(0.78-1.07)	-0.29
Dorsopathy	1.88	1.07	(0.88-1.30)	0.13
Migraine or severe headaches	1.37	1.21	(0.98-1.49)	0.30
Severe infection	0.96	**1.37**	(1.08-1.73)	0.36
Type 1 diabetes	0.71	1.09	(0.82-1.47)	0.07
Visual or hearing impairment	0.73	1.08	(0.81-1.44)	0.07
Epilepsy	0.83	**1.60**	(1.28-2.01)	0.53
Congenital heart disease	0.49	**1.47**	(1.08-2.01)	0.24
Rheumatoid arthritis	0.41	1.29	(0.88-1.89)	0.11
Celiac disease	0.21	1.05	(0.56-1.98)	0.01
Inflammatory bowel disease	0.22	0.91	(0.47-1.78)	-0.02
Cancer	0.18	0.84	(0.40-1.79)	-0.03
Cerebral palsy	0.16	1.73	(0.98-3.07)	0.11
Other somatic conditions	28.03	**1.18**	(1.11-1.24)	4.87
Mental disorders	7.96	**2.18**	(2.04-2.33)	10.76
Unipolar depression	1.78	**2.26**	(2.00-2.56)	2.63
Specific developmental disorder	1.63	**1.57**	(1.36-1.81)	1.22
Conduct disorder	1.24	**2.64**	(2.36-2.94)	3.42
Anxiety	0.84	**2.43**	(2.06-2.86)	1.34
ADHD	0.48	**1.89**	(1.51-2.37)	0.66
Eating disorder	0.47	1.44	(1.00-2.07)	0.16
Substance-abuse disorder	0.53	**2.37**	(1.99-2.83)	1.03
Pervasive developmental disorder	0.35	**1.90**	(1.42-2.53)	0.42
Psychosis	0.29	**2.74**	(2.13-3.52)	0.60
Other mental disorders	2.95	**1.96**	(1.78-2.16)	3.69
Injury	17.55	**1.26**	(1.18-1.34)	4.75
Fracture	8.74	**1.13**	(1.04-1.23)	1.30
Intracranial injury	1.36	**1.29**	(1.07-1.55)	0.44
Other injury	9.85	**1.34**	(1.25-1.45)	3.62

[a]Risk ratios (RR) in bold statistically significant at the 0.05 level

[b]Separate models for different health conditions

[c]Population born in 1988–1995

The last aim of sub-study I was to examine sex differences and comorbidity. Figure 4 presents the sex-specific RRs of the broad groups of health conditions at age 21. Somatic conditions and mental disorders were associated with larger RRs of dropout among girls than boys. However, at age 17, there were no sex differences in the strength of the associations, and even at age 21, the

(unadjusted) absolute increase in the probability of dropout at age 21 between adolescents with and without mental disorders was 13.9 percentage points for girls and 16.0 percentage points for boys. When all three types of health conditions were included in the model simultaneously, the associations of somatic conditions became even weaker than in the models only adjusting for control variables. A further analysis, omitting injuries, revealed that this decrease in effect size was fully attributable to mental disorders. When a similar comorbidity analysis was conducted for the more specifically defined health conditions (all 25 health conditions were included simultaneously), the previously reported associations became weaker but remained substantially similar. As an exception, the associations of dorsopathies and eating disorders virtually vanished at this point.

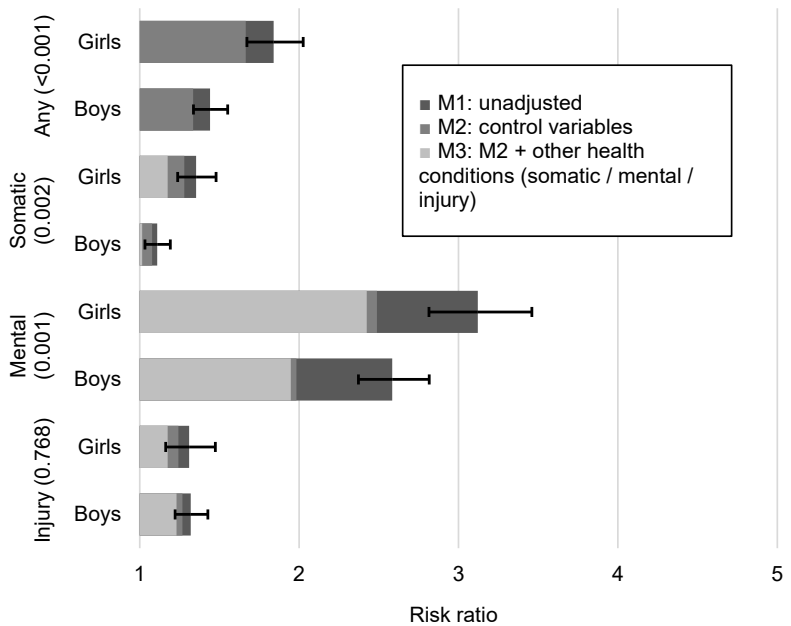

Figure 4 Crude and adjusted RRs of dropout from upper-secondary education at age 21 (n = 50,327) according to the presence of health conditions at ages 10–16 years by sex and the type of health condition: 95% CIs for Model 1 (M1) and *P* values (in parentheses) for the sex difference in Model 2 (M2).

7.2 UPPER-SECONDARY NON-COMPLETION AND TRACK CHOICE—THE ROLE OF SCHOOL PERFORMANCE

Sub-study II extended the analysis of health-related selection to upper-secondary education by simultaneously focusing on non-completion and track choice (general track vs. vocational track) and by assessing poor school

performance (as measured by grade point average) as a potential mechanism explaining the associations. Figure 5 depicts the results of a three-way mediation decomposition, which divided the total effect of health problems on non-completion into a *pure direct effect* (part unexplained by school performance), a *pure indirect effect* (health problems affect school performance and this change affects educational outcomes as much as could be expected), and a *mediated interaction effect* (health problems affect school performance and this change affects educational outcomes either more or less than could be expected). The decomposition was conducted both adjusting for confounders and using sibling fixed-effects models.

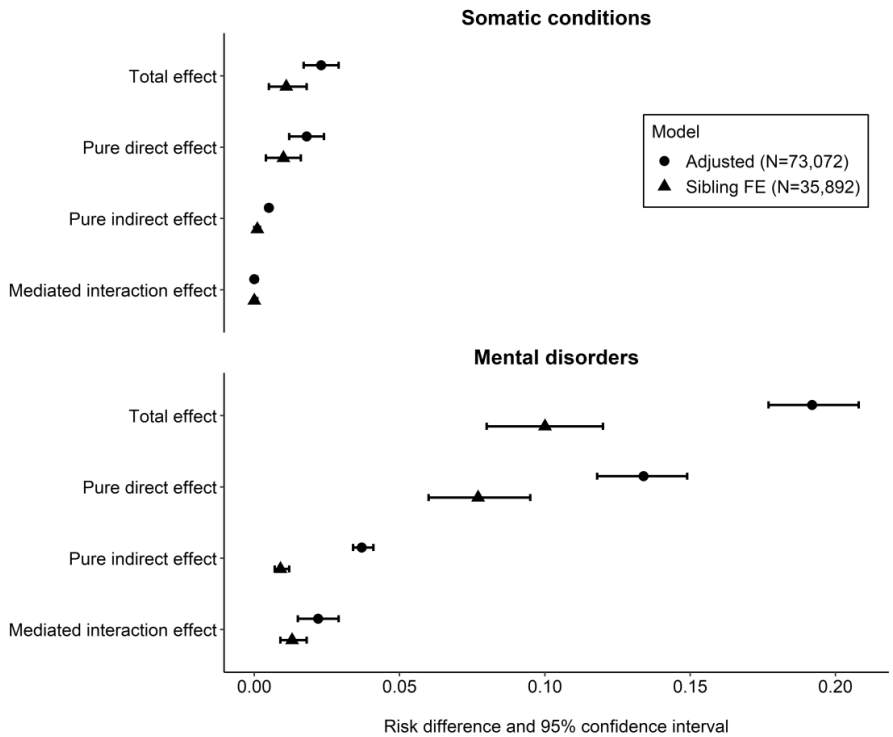

Figure 5 A three-way decomposition of the total effect of somatic conditions and mental disorders at ages 10–16 on the probability of not completing upper-secondary education by age 23, mediated by grade point average. Adjusted models adjust for all control variables, whereas sibling fixed-effects (FE) models adjust for sex.

Overall, adolescents who experienced somatic conditions at ages 10–16 had a 2.3 percentage point higher likelihood of not attaining any type of upper-secondary education by age 23. For those experiencing mental disorders in early adolescence the same decrease was 19.2 percentage points. Up to 22% of the effect of somatic conditions and 31% of the effect of mental disorders was due to reductions in school performance, which was mostly due to a process

where the reductions in school performance resulted in expectedly large increases in non-completion (pure mediation instead of mediated interaction). However, in the case of mental disorders, the analysis also produced a small (positive) mediated interaction effect, indicating that reductions in school performance lead to larger-than-expected increases in non-completion. In sibling fixed-effects models, the total effects were roughly half of the adjusted total effects and the contribution of poor school performance became slightly smaller.

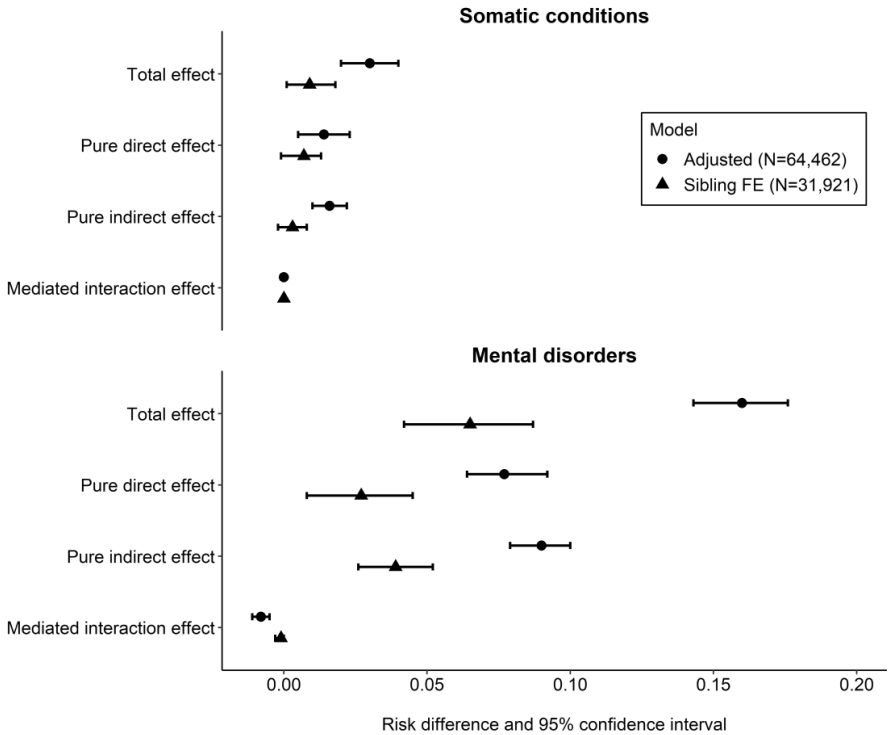

Figure 6 A three-way decomposition of the total effect of somatic conditions and mental disorders at ages 10–16 on the probability of completing the vocational track instead of the general track in upper-secondary education by age 23, mediated by grade point average. Adjusted models adjust for all control variables, whereas sibling fixed-effects (FE) models adjust for sex.

When similar decompositions were conducted for upper-secondary track choice, somatic conditions increased the likelihood of choosing the vocational track (instead of the general track) by 3 percentage points and mental disorders by 16 percentage points (Figure 6). Proportions mediated by grade point average were seemingly larger than in the case of non-completion—more than 50%—and they were fully due to pure mediation. The effects observed in

sibling fixed-effects models were roughly one-third of the original effects, but the conclusions regarding mediation remained substantially similar.

The analysis on track choice pertained only to those attaining an upper-secondary degree by age 23, and even in this group, the analysis ignored the process that lead to the completion of the observed track. In a sensitivity analysis, the outcome variable was defined as listing the vocational track as the first preference when participating for the first time in the upper-secondary school application process. Notably, the decomposition results were nearly identical with the original three-way decomposition based on completed education.

In additional analyses, externalizing spectrum disorders (ADHD and conduct disorders) showed both larger total effects and stronger mediation by school performance than internalizing spectrum disorders (depression and anxiety). The more strictly defined indicators of somatic conditions (treatment in 4+ years and complex chronic conditions) showed total effects that were comparable to that of the broad group of somatic conditions. However, school performance did not mediate the association between complex chronic conditions and educational outcomes.

7.3 THE CONNECTIONS BETWEEN PARENTAL EDUCATION AND HEALTH-RELATED SELECTION TO EDUCATION

Sub-study III approached the connections between parental education and health selection from two intertwined perspectives: parental education as a moderator of health selection and health problems as mediators of the intergenerational transmission of educational attainment. In addition to analyzing selection to upper-secondary education, the study was able to highlight health-related selection to tertiary education as a separate phenomenon.

Figure 7 shows the basic associations of health problems with secondary and tertiary education at age 27, based on fully adjusted linear probability models and sibling fixed-effects linear probability models. The group of somatic conditions, consisting of ten chronic conditions, showed a consistent but relatively weak association with secondary education. In the adjusted models, somatic conditions decreased the likelihood of completing a tertiary degree (among those with secondary education), but this decrease could not be seen in the sibling fixed-effects models. Surprisingly, the associations between frequent infections (defined based on antimicrobial drug purchases) and educational attainment were slightly stronger in the fixed-effects models than in the regular adjusted models. Mental disorders predicted the largest decreases in both secondary and tertiary education, but these associations were also more sensitive to unobserved confounding. In the adjusted models, mental disorders decreased the probability of secondary education by 17.1

percentage points and that of tertiary education by 14.7 percentage points. Within sibships, the reductions were 11.9 percentage points for secondary education and 10.7 percentage points for tertiary education.

Although the Finnish education system does not contain formal dead-ends, continuing to tertiary education is more common among those completing the general track in upper-secondary education. To evaluate how much health-related selection to tertiary education overlaps with selection to different tracks in upper-secondary education, sub-study III also estimated the basic associations of tertiary education adjusted for track choice (Figure 7). At this point, somatic conditions lost their association, but mental disorders were still associated with a 6 percentage point reduction in the completion of tertiary education within sibships.

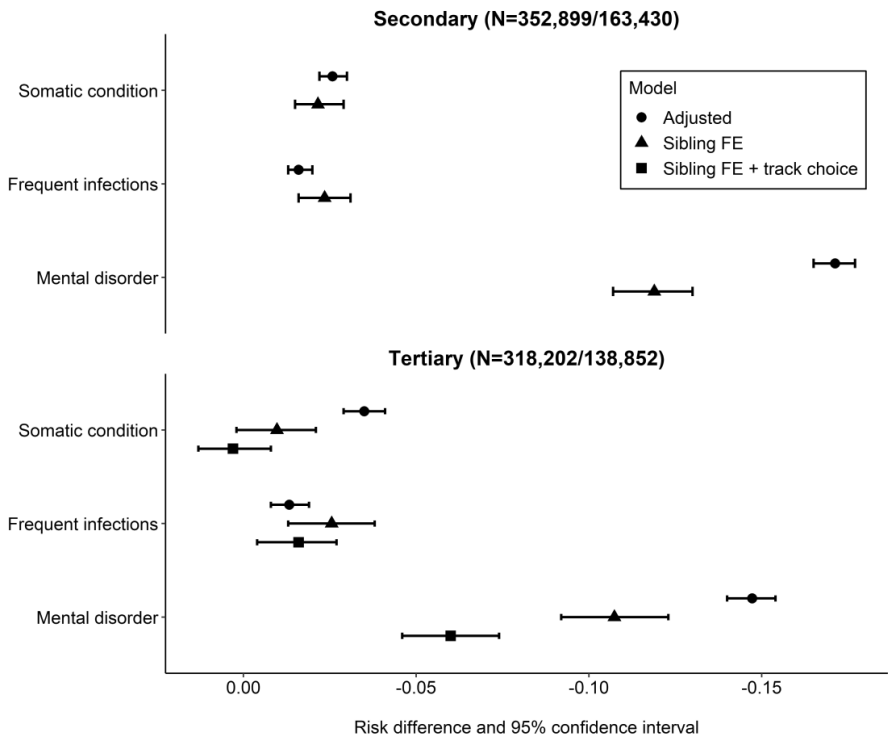

Figure 7 The associations between different types of health problems at ages 10–16 and secondary/tertiary education at age 27. Adjusted models adjust for all control variables; sibling fixed-effects (FE) models adjust for birth year and sex; and sibling fixed-effects models with track choice adjust for birth year, sex, and the study track of the completed upper-secondary degree.

The association between mental disorders and secondary education was slightly weaker in families with high parental education (Figure 8). However, in predicting tertiary education, mental disorders exhibited the largest

reductions among the offspring of highly educated parents. No evidence of moderation was observed for other types of health problems.

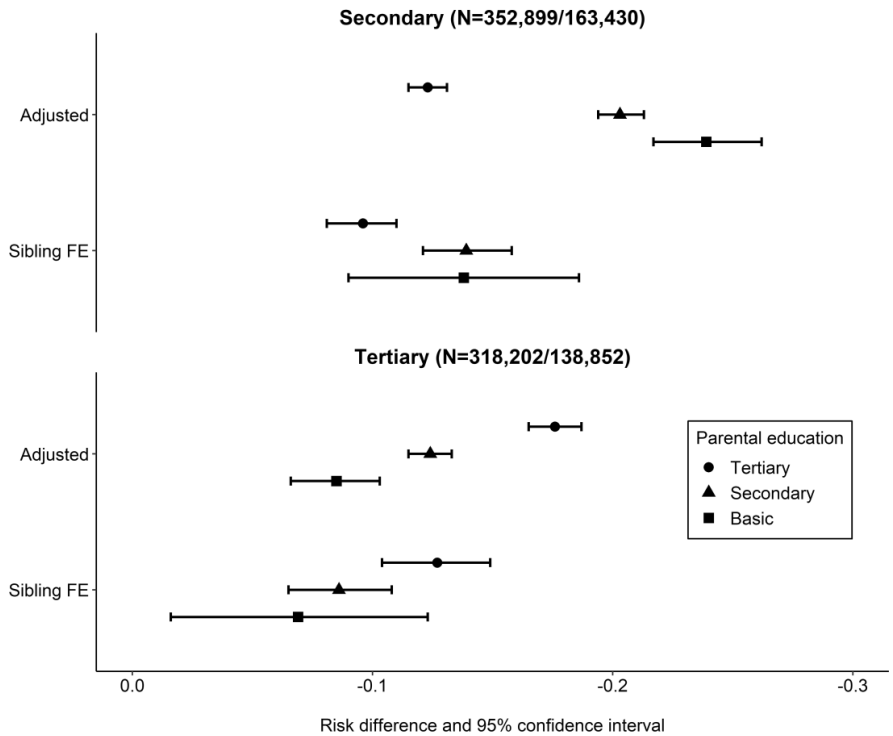

Figure 8 The association between mental disorders at ages 10–16 and secondary/tertiary education at age 27 by parental education. Adjusted models adjust for all control variables, whereas sibling fixed-effects (FE) models adjust for birth year and sex. P-values testing the equivalence of coefficients: <0.001 (secondary, adjusted), 0.001 (secondary, FE), <0.001 (tertiary, adjusted), and 0.017 (tertiary, FE).

To better understand the observation that high parental education augments the impact of mental disorders on tertiary education, sub-study III included two supplementary analyses focusing on upper-secondary track choice. First, the increase in choosing the vocational track in upper-secondary education, already observed in sub-study II, was even larger among adolescents with high parental education. Second, when selection to tertiary education was assessed separately according to both parental education and upper-secondary track choice, the original moderation pattern could only be observed among those completing the vocational track. In this group, the baseline probabilities of completing tertiary education were low enough to prevent a large reduction due to mental disorders—especially among those with secondary or basic parental education.

The analysis on the intergenerational transmission of education used g-computation to decompose the total effect of parental education on offspring education into the controlled direct effect (part remaining following a hypothetical eradication of somatic conditions, frequent infections, and mental disorders) and the portion eliminated (Table 3). The decompositions were conducted separately for the completion of secondary and tertiary education (the latter among those with completed secondary education), adjusting for all control variables. Overall, young people with tertiary parental education were 18.6 percentage points more likely to attain secondary education by age 27 than young people with basic parental education and 31.0 percentage points more likely to attain tertiary education. In the case of secondary education, the hypothetical eradication of health problems eliminated up to 1.9 percentage points (or 10%) of the original association, whereas in the case of tertiary education, the original associations became up to 0.7 percentage points (or 2%) stronger.

Table 3. *Decomposition of the contribution of adolescent health problems to differences in the completion of secondary (N=352,899) and tertiary education (N=318,202) according to parental education, with basic education as the reference category*

A) Secondary education

Parental education	Total effect	Controlled direct effect	Portion eliminated
Basic (ref.)			
Secondary	0.113 (0.107, 0.118)	0.101 (0.094, 0.108)	0.012 (0.007, 0.016)
Tertiary	0.186 (0.180, 0.192)	0.167 (0.160, 0.174)	0.019 (0.015, 0.024)

B) Tertiary education (among those with completed secondary education)

Parental education	Total effect	Controlled direct effect	Portion eliminated
Basic (ref.)			
Secondary	0.083 (0.076, 0.089)	0.087 (0.078, 0.095)	-0.003 (-0.009, 0.002)
Tertiary	0.310 (0.303, 0.316)	0.317 (0.309, 0.326)	-0.007 (-0.012, -0.002)

8 DISCUSSION

This dissertation set out to provide a more complete picture of health-related selection to education than has been previously available. The idea was to expand our current understanding of the association between health problems and education in three aspects: the weight of different types of health problems, the manifestation of health selection at different levels of education, and the connection between social origin and health-related selection to education. This section discusses the main results in light of what was previously known about these topics and what is warranted by the chosen methodology. The section concludes with a brief discussion on the theoretical implications of the results.

8.1 MAIN FINDINGS AND THEIR INTERPRETATION

8.1.1 THE IMPACT OF DIFFERENT TYPES OF HEALTH PROBLEMS

Previous research on health-related selection to education is dominated by indicators of prenatal health (Case and Paxson 2010; Currie et al. 2010), self-rated health (Jackson 2009; Lê et al. 2013; Lynch and von Hippel 2016), proxies of health such as height (Blane et al. 2007; Cernerud 1995), and selections of one or a few specific health conditions (Champaloux and Young 2015; Dahlquist and Källén 2007; Fletcher 2010; Fried et al. 2016). One of the central aims of this study was to broaden the scope by simultaneously assessing different types of health problems in early adolescence, a period of life when individuals are expected to make important educational decisions. Specific emphasis was placed on the distinction between somatic conditions and mental disorders, which was featured in all three sub-studies.

Overall, the results unanimously showed that mental disorders pose the largest and most persistent educational risk for young people, albeit all sub-studies displayed a weak association for somatic conditions, robust to adjustments. This result is in line with the small number of previous research that warrants the comparison of somatic conditions and mental disorders (Van Der Heide et al. 2016; Layte and McCrory 2013; De Ridder et al. 2013; Uiters et al. 2014). However, the sub-studies of the present thesis were able to estimate the basic associations of somatic conditions and mental disorders with a much larger sample than has previously been available. Sub-studies II and III were even able to use sibling fixed-effects models to adjust for all confounding shared within sibships. De Ridder et al. (2013) used the same method, but their smaller sample size could explain why they were unable to

observe an association between somatic conditions and upper-secondary school dropout within sibships.

Notably, the magnitude of the association between the general group of somatic conditions and upper-secondary educational outcomes was quite similar regardless of what health conditions were included in the group. The main analyses of sub-studies I and II used a very broad definition of somatic conditions, but these associations did not markedly differ from the ones produced by the sub-group of complex chronic conditions in sub-study II or a hand-picked selection of ten chronic conditions in sub-study III. The dataset used in the study included few options to evaluate this observation, but it can be speculated that increasing severity signals increasing recognition and support. As was noted in the background section, children with the most severe cases of illness attend hospital schools combining teaching and treatment (Sairaalaopetus 2020).

Besides the straightforward distinction between somatic conditions and mental disorders, sub-study I examined the associations between 25 specific health conditions and dropout from upper-secondary education. The social consequences of asthma, type 1 diabetes, childhood cancer, and inflammatory bowel disease have attracted a plethora of previous research (Boman et al. 2010; Dahlquist and Källén 2007; Fletcher and Richards 2012; Koch et al. 2004; Kuehni et al. 2012; Lancashire et al. 2010; Mayberry et al. 1992; Mazurek et al. 2012; Persson et al. 2013; Ross et al. 1992; Singh et al. 2015), but none of these conditions were consistently associated with upper-secondary dropout status both at age 17 and at age 21 in the present study. With regard to asthma and inflammatory bowel disease, the null results are in line with earlier research, but in the case of type 1 diabetes, some previous studies have reported weak associations with impaired school performance and school dropout in Sweden (Dahlquist and Källén 2007; Persson et al. 2013) and the United States (Fletcher and Richards 2012). As for childhood cancer, the observation that those surviving the disease have a heightened risk of non-attendance at age 17 but no longer at age 21 can be interpreted as a sign of a delayed educational career. In previous research, only leukemia and central nervous system tumors have predicted more persistent educational problems (Koch et al. 2004; Kuehni et al. 2012; Lancashire et al. 2010).

The study was also able to shed light on health conditions that have thus far received little attention in health selection research. Sub-study I indicated epilepsy and congenital heart disease to be strongly associated with dropout status even at age 21. Although the potential educational risks related to epilepsy have been noted by some authors (Berg et al. 2016), both of these health conditions clearly deserve further research. Along the same lines, sub-study I indicated severe infections and sub-study III frequent infections to implicate lower educational attainment in young adulthood. This finding seems vulnerable to environmental confounding, but surprisingly, the association between frequent infections and education became even stronger when it was estimated between biological siblings sharing the familial

environment. It would be useful to examine in further research what the role of increased school absenteeism is in explaining these associations.

Sub-studies I and II were able to produce novel evidence on the relative significance of different types of adolescent mental disorders. In line with previous research, both studies observed externalizing spectrum disorders (e.g., ADHD, conduct disorders, and substance abuse) to carry the largest educational risks (Breslau et al. 2011; Evensen et al. 2016; Kessler et al. 1995; McLeod et al. 2012). However, the results of the present study were in contrast with some earlier research implying that the association between internalizing spectrum disorders (e.g., depression and anxiety) and educational outcomes is fully explained by comorbid externalizing spectrum disorders (Breslau et al. 2011; Evensen et al. 2016; Fergusson and Woodward 2002); in the analyses of sub-study I and sub-study II, the associations of depression and anxiety remained strong even after controlling for externalizing. It seems plausible that specialist diagnoses (the present study) and symptom questionnaires (earlier research) paint a different picture of the independent contribution of internalizing and externalizing.

Almost all previous research revolves around the question of whether health problems increase the likelihood—in either absolute or relative terms—of achieving a lower education. In contrast, very few studies have attempted to calculate the contribution of health problems to population-level variation in educational attainment. Based on adjusted population-attributable fractions, sub-study I estimated that roughly one-fifth of dropout from upper-secondary education at age 21 is attributable to early-adolescent health conditions, whereas mental disorders alone showed an attributable fraction of 11%. In contrast, a previous study from the United States reported that 46% of high-school noncompletion—a more extreme outcome than in the present study—was attributable to mental disorders, without controlling for confounders (Stoep et al. 2003). These types of calculations are instructive for health and education policy because they highlight the matter of perspective: common health conditions with moderate "effects" (e.g., depression and anxiety) could be important in explaining educational dropout as a population phenomenon, whereas rare conditions with strong "effects" (e.g., psychosis, congenital heart disease, and epilepsy) rather pose a large individual-level risk.

8.1.2 THE DIFFERENT STAGES OF SELECTION

Probably because of the weak availability of datasets combining measures of early health with a long follow-up of education, most previous studies focus on the timely completion of upper-secondary education (Fried et al. 2016; Van Heesch et al. 2012; Van Der Heide et al. 2016; Maslow et al. 2011; De Ridder et al. 2012; Stoep et al. 2003). Among the sub-studies of the present dissertation, sub-study I continued this tradition by examining dropout from upper-secondary education at ages 17 and 21. The aim of these analyses was to produce novel evidence on the contribution of different types of health

problems (discussed above). However, this dissertation was also able to broaden the perspective by examining long-term educational outcomes (upper-secondary and tertiary education at age 27), horizontal stratification (track choice in upper-secondary education), and the path-dependence of educational careers.

The results of sub-study III implied that health problems not only delay educational careers but also leave some persons with a permanently lower level of education. The health-related differences in the completion of secondary education were still present at age 27; what is more, among those completing secondary education, health problems in early adolescence further predicted a lower likelihood of attaining a tertiary degree by this age. Few earlier investigations have been able to examine postsecondary educational outcomes, notwithstanding retrospective studies.

A previous study from Finland observed early-onset psychiatric disorders to predict a lower likelihood of both completing a secondary education and completing a tertiary education by age 31 (Isohanni et al. 2001). However, the study included only 359 psychiatric cases and defined the early age of onset to cover disorders emerging before the age of 22. Other studies have examined the likelihood of postsecondary enrollment as predicted by poor self-rated health (Haas and Fosse 2008) and psychiatric disorders (Evensen et al. 2016; Fletcher 2010; Needham 2009). In contrast to the results of sub-study III, some of these investigations report that the association between health problems and immediate postsecondary enrollment is either fully or mostly explained by the prior completion of secondary education (Fletcher 2010; Haas and Fosse 2008). This inconsistency in results suggests that the ultimate health-related differences in postsecondary attainment could be larger than what is implied by the initial differences in enrollment.

In addition to assessing whether health problems are associated with attaining a lower level of education (vertical stratification), the study also examined the health-related selection of individuals into different tracks in upper-secondary education (horizontal stratification). These analyses demonstrated that early-adolescent health problems are associated with completing the vocational track instead of the more academically oriented general track. What is more, adolescents with health problems were more likely to prefer the vocational track when applying to upper-secondary education, which suggests that the result is not explained by a failure to complete the general track. Horizontal stratification has received almost no attention in the health selection literature, but the idea has been occasionally featured in disability studies. In line with the results of sub-study II, Chatzitheochari and Platt (2019) reported that adolescents with disabilities had lower university expectations than adolescents without disabilities. Accordingly, adolescents "labeled" with a learning difficulty were less likely to complete college preparatory coursework (Shifrer et al. 2013).

Altogether the results suggest that adolescents with health problems or disabilities anticipate a lower level of education in their educational decisions.

This interpretation was further supported by the observation that impaired school performance at the end of compulsory schooling explained only about one-third of the health-related differences in the non-completion of upper-secondary education and roughly half of the differences in track choice. With regard to non-completion, previous studies have reported slightly larger mediation proportions (Jackson 2009; Sagatun et al. 2014). However, these studies were based on self-rated health, and it is conceivable that with an increasing severity of health problems, the role of negative expectations becomes elevated. A previous study on adolescents with severe disabilities observed that parents' educational expectations were especially important predictors of high school completion, net of past school performance (Shandra and Hogan 2009). At the very least, the results of the present study show that a large proportion of the discontinued and less academically oriented educational careers of adolescents with health problems is explained by factors other than poor school performance.

Sub-study III demonstrated that the observed health-related differences in upper-secondary track choice foreshadow vertical stratification in tertiary education. When adjusting for upper-secondary track choice, the group of chronic somatic conditions was no longer associated with tertiary education, and mental disorders lost almost half of their original association. Thus, even in a system without absolute educational dead-ends, the health-related differences in early educational outcomes seem rather permanent when analyzed in the long-term. Overall, the significance of choosing the vocational track is surprisingly large considering that for some persons with physically limiting health conditions a non-physical white-collar profession may be the only available option (Teachman 2012). At the same time, it is noteworthy that early-adolescent mental disorders decrease the likelihood of completing a tertiary education by six percentage points even when accounting for all selection taking place in upper-secondary education and all factors shared within sibships. Early-onset mental disorders are known to be highly persistent and recurrent (Patton et al. 2014), which could explain why they seem to show such long-lasting effects on educational attainment.

8.1.3 SOCIAL ORIGIN AND HEALTH-RELATED SELECTION TO EDUCATION

Besides documenting long-term educational outcomes, sub-study III examined the overall chain of associations formed by parental education, adolescent health problems, and educational attainment. In support of the resource mobilization and cumulative disadvantage hypothesis, the analyses on moderation by parental education observed that high parental education alleviates the impact of mental disorders on secondary education. However, in the case of tertiary education, the associations of mental disorders were the strongest among adolescents with highly educated parents.

Overall, these results fit into the general pattern suggested by earlier studies that socially advantaged parents may be able to provide additional support for their offspring with health problems at the early stages of education (Jackson 2015), but no longer in young adulthood (Evensen et al. 2016; Flouri 2007; Jackson 2009). Whereas some previous studies on moderation use combination indicators of somatic conditions and mental disorders (Jackson 2009, 2015), the present study demonstrated that the observed pattern of moderation applies only to mental disorders: somatic conditions or frequent infections posed a small educational risk regardless of parental education. In line with the result regarding stronger associations between mental disorders and tertiary education among highly educated parents, Flouri (2007) has previously observed that the association between early hyperactivity and education is stronger among children with a highly educated mother. In the present study, this pattern was explained by the fact that adolescents with high parental education showed the largest increases in choosing the vocational track in upper-secondary education after experiencing health problems. This observation supports the hypothesis that socially advantaged adolescents have further to fall in their educational expectations and deserves to be examined more thoroughly in future research.

Sub-study III also tested the hypothesis that early health problems mediate the intergenerational transmission of educational attainment. This hypothesis was based on the presence of educationally relevant health disparities (low parental SEP increasing the incidence of health conditions that have a negative impact on education), hypothesized by some authors (Basch 2011; Case and Paxson 2006; Palloni 2006). The results implied that a hypothetical eradication of early-adolescent health problems would diminish the contribution of parental education to offspring secondary education up to 10% but increase its contribution to tertiary education up to 2%. These results align with earlier studies reporting either small (Sznitman et al. 2017) or null (Hoffmann et al. 2018) mediation of intergenerational socioeconomic attainment via child or adolescent health problems.

Compared with previous work, the study was able to include a broader range of severe health problems in the analysis and elucidate the associations with the moderation analyses reported above. In the case of secondary education, the moderation of health selection by parental education amplifies mediation, whereas in the case of tertiary education, health problems have a leveling impact because the offspring of highly educated parents show a larger increase in vocational upper-secondary education. Overall, parental education and adolescent health problems are both important predictors of educational attainment, but their contributions seem to operate largely independent of each other. When interpreting the results on intergenerational transmission, it should be noted that the present study captured only a segment of early health. An ideal intergenerational study would include a broad range of indicators ranging from prenatal health (Carvalho 2012; Härkönen et al. 2012) to different aspects of child and adolescent health (Hoffmann et al. 2018;

Manor et al. 2003; Sznitman et al. 2017), possibly extending into late adolescence and early adulthood.

8.2 METHODOLOGICAL CONSIDERATIONS

8.2.1 THE MEASUREMENT OF HEALTH PROBLEMS

Data on inpatient and outpatient visits and medication reimbursements were used to identify the presence of health problems at ages 10–16. All data sources included diagnoses issued by medical specialists, which enabled the accurate and reliable measurement of different types of health problems. Given the predominance of self-reported health measures in previous studies, specialized care data is likely to shift the focus to more severe health conditions on average and exclude health conditions that are typically addressed by general practitioners or are invisible to healthcare providers (e.g., mild forms of depression). The focus on more severe health conditions can be considered to complement existing literature as long as it is achieved in an unbiased manner.

The sub-studies of the present dissertation were able to adjust for the most obvious socioeconomic and regional predictors of treatment seeking. Sub-studies II and III additionally used sibling fixed-effects models, which had the benefit of eradicating many potential sources of bias: biological siblings experience a largely similar home environment and usually even go to the same school. Moreover, all sub-studies used a seven-year age span to measure health conditions, thus rendering both random and systematic variation in the detection of health problems smaller than would have assumedly been the case in a cross-sectional or retrospective study design. Finally, extensive health examinations, conducted in all Finnish schools, and the highly subsidized Finnish healthcare system mitigate the role of parents in treatment seeking and financing care (Ministry of Social Affairs and Health 2013). This was particularly important for the intergenerational analyses of sub-study III that relied on the correct estimation of disparities in adolescent health problems according to parental education. An older study from Finland did not observe differences according to parental education in the propensity of seeking treatment for adolescent mental disorders (Sourander et al. 2001).

Even if the estimates are relatively unbiased in terms of socioeconomic and regional factors, some amount of undercoverage seems inevitable when using register data. Certain chronic conditions, such as asthma, type 1 diabetes, or ADHD, could have been diagnosed before age 10, and thereafter treated with medications only. Sub-study III was able to use medication reimbursement data to supplement the inpatient and outpatient records, whereas sub-studies I and II relied solely on inpatient and outpatient data. In the case of sub-study I, this may have resulted in a slight underestimation of the prevalence of health problems and, consequently, the population-attributable fractions, assuming

that the risk ratios of dropout would have remained the same with the inclusion of unobserved cases.

8.2.2 THE MEASUREMENT OF EDUCATIONAL OUTCOMES

The register-based follow-up of educational attainment was one of the evident strengths of the present dissertation. It enabled the objective identification of different levels of education and the analyses of interdependencies between different educational outcomes (school performance and track choice; track choice and tertiary education). With register data, sub-study III was able to examine the intergenerational association between parental education, adolescent health problems, and the completion of secondary and tertiary education by age 27 without relying on retrospective data or obstructing the temporal ordering of variables at any stage. As noted above, few previous health selection studies have been able to examine postsecondary educational outcomes.

In sub-study II, roughly 1.2% of the study population was excluded because these persons did not have information on grade point average in the data. A sensitivity analysis implied that the total effects of health problems on upper-secondary outcomes were slightly underestimated because of this exclusion criterion. Along the same lines, sub-study III raised the concern of whether age 27 is high enough to reflect the highest level of education that a person will eventually complete. A sensitivity analysis, assuming that enrolled students will ultimately attain the degree they are pursuing, showed that the associations of health problems and tertiary education would have remained similar had these persons completed their studies by age 27.

In addition to these limitations regarding the measurement of education, it is worth noting that some foreign degrees could be missing from the registers because it is up to the persons themselves to report them to the register authorities (Finnish National Agency for Education 2020a). However, this is unlikely to cause any major bias considering that most immigrants and emigrants were excluded from the study sample because of the requirement to be present both at ages 10–16 and at the age when educational attainment was measured.

8.2.3 THE CAUSALITY AND MECHANISMS OF HEALTH SELECTION

The background section introduced several theoretical reasons to assume that early health problems have a causal effect on educational outcomes. Unfortunately, the register-based dataset used in the analyses provided few possibilities to examine the foundational-level mechanisms that contribute to the associations (e.g., declined future orientation, reduced educational expectations, cognitive impairment, and stigmatization). Whereas survey data may be a necessity for answering questions about mechanisms, the use of register data involved other unique benefits that supported the inference.

Importantly, the annual longitudinal measurement made it possible to distinguish the temporal ordering of health problems and educational outcomes—a necessary but not sufficient condition for estimating causal relationships (VanderWeele and Tchetgen Tchetgen 2017). Although the analyses did not fully rule out the possibility that early (unobserved) school failures might have reinforced the incidence of certain mental disorders, the measurement period of health problems nevertheless temporally preceded the outcomes of interest. What is more, instead of only measuring the highest achieved education, the study was able to track the pathways leading to the observed attainment (earlier school performance and track choice).

Assessing the presence of a causal effect between two variables (even if temporally ordered) is always a daunting task, but it is increasingly so when the goal is to measure the causal effect of health problems on schooling. First, we are limited to observational data because it would be both unfeasible and unethical to conduct a randomized experiment where the experimental group is either deliberately exposed to a health shock or deprived of an effective treatment. Second, it is also notoriously difficult to discover sources of *exogenous variation* in health problems—variation clearly unrelated to the outcome—that could be leveraged to identify causal associations with observational data. Economists have used changes in schooling laws as *natural experiments* to evaluate the causal effect of increased education on health (Kemptner, Jürges, and Reinhold 2011), but even based on their own literature review, opportunities seem to be much more limited when studying the effect of health on education (Eide and Showalter 2011). While data on pandemics and radioactive fallouts have provided effective ways to examine the impact of harmful in utero exposures to educational outcomes (Almond 2006; Almond, Edlund, and Palme 2009), no study reviewed by Eide and Showalter (2011) identifies a natural experiment related to childhood chronic conditions or mental disorders.

In line with a minority of previous studies on health-related selection to education (Currie et al. 2010; Evensen et al. 2016; Fletcher 2010; Fletcher and Wolfe 2008; Haas and Fosse 2008; Jackson 2009; Lê et al. 2013; De Ridder et al. 2013; Roos et al. 2013), sub-studies II and III employed sibling fixed-effects models to advance a step further from regular adjusted estimates. These models restrict the estimation to within-sibship variation and by doing so automatically eradicate all confounding that is shared by full siblings living in the same family, i.e., common environmental conditions and on average 50% of genetic makeup (Frisell et al. 2012). This can be considered a sizable benefit, given that the most obvious confounders of the association between adolescent health problems and education are related to family background. Compared with previous studies, sub-study II was able to extend the use of sibling fixed-effects models to estimate the association between health problems and educational attainment, as mediated by impaired school performance. Sub-study III used the largest sample of siblings to date to estimate the association of health problems with secondary and tertiary

education. Even moderation by parental education could be tested reliably, for which previous samples may have been too small (Evensen et al. 2016; Jackson 2009).

As a downside, sibling fixed-effects models involve several limitations and potential biases that restrict their use as an unequivocal trial of causal relationships. Most obviously, these models do not adjust for factors that are *not shared* by full siblings, including separate genetic makeup and unique environmental exposures. This leaves some room for factors like cognitive and noncognitive skills and child-specific parenting practices to potentially confound the relationship (see section 2.4.4 for further discussion on individual confounders). In fact, because sibling comparison designs rely on a preselected sample of sibling pairs that differ in exposure, they are particularly susceptible to bias caused by non-shared confounders and the attenuation of associations due to measurement error (Frisell et al. 2012). Moreover, the estimates produced by sibling models could be further attenuated if health problems in one sibling affect the other siblings' educational outcomes. For instance, having a hyperactive or ill-behaving sibling in the family could make it difficult for other children to focus on their schoolwork (Sjölander, Frisell, et al. 2016). Despite these words of caution, sibling fixed-effects models, combined with a large sample size, provide a unique opportunity to test the assumption that familial confounding explains a major part of an observed association (Frisell 2020). The difference between the adjusted and fixed-effects estimates was rather small in most scenarios in the present study, which increases the credibility of the results.

Notwithstanding the difficulties of evaluating the causality of health–schooling relationships, the previous literature includes some promising ways forward. Ding et al. (2009) used genetic markers as instrumental variables for health problems, showing that both obesity and depression caused a roughly one standard deviation reduction in grade point average. The case for ADHD was less clear; however, the authors noted the complexity of identifying individual genetic markers to separate between comorbid health conditions (Ding et al. 2009). Similarly, many studies have used comparisons of monozygotic twins to examine the impact of low birthweight on schooling (Fletcher 2011; Jelenkovic et al. 2018; Miller et al. 2005). Since differences between identical twins cannot be caused by different inheritance, this method could also be used to better adjust for genetic confounding when examining the effect of child or adolescent health problems on educational outcomes. It should be noted, however, that the limitations of sibling fixed-effects models, outlined above, mostly apply to comparisons of health-discordant twins as well (Frisell et al. 2012; Sjölander, Frisell, et al. 2016). Finally, the children-of-twins design has proved useful in disentangling the genetic and environmental components of the intergenerational transmission of mental disorders (McAdams et al. 2014). The method could prove similarly valuable when studying the contribution of health problems to the intergenerational transmission of SEP.

8.2.4 EXTERNAL VALIDITY

As for the generalizability of results, the first question is whether we can generalize the findings to the Finnish population with confidence. The use of register data involves many benefits that can be assumed to support this type of external validity. Whereas longitudinal survey studies are vulnerable to selective attrition (Wolke et al. 2009), the only sources of loss to follow-up that this study encountered were caused by deaths and emigration, resulting in the exclusion of less than 0.5% of the original population in each sub-study. Along the same lines, survey respondents may leave some questions unanswered or answer fallaciously due to social desirability or recall bias (Brenner and DeLamater 2014), whereas most register data—including data on healthcare use and educational attainment—is collected routinely.

It follows from here that the most important threats to generalizability at the national level were likely caused by the decisions that were made to fortify internal validity. Most importantly, sub-study II excluded adolescents who did not live with at least one parent or guardian at ages 10–14 and sub-study III excluded persons who did not live with a least one biological parent at the same ages. These exclusions ensure that the measured sociodemographic and -economic factors reflect the living circumstances of the study population, but they preclude the generalization of the results to children living in out-of-home care. Likewise, the estimation of sibling fixed-effects models required the identification of biological parents, leaving many immigrant children outside the sample. It seems plausible that the exclusion of such vulnerable groups of children may have rendered the results more conservative. Because sibling fixed-effects models require within-family variation in health problems, their results cannot be automatically generalized to only children or families with all children experiencing health problems.

The other noteworthy question is whether the results of the present study provide useful insights for other countries. When presenting the Finnish context, it was argued that the special aspects of the Finnish education system (the lack of tuition fees, dead-ends, and early tracking) provide an extraordinary setting—a kind of laboratory—for evaluating the basic processes of health-related selection to education. At the same time, the specialty of the Finnish system may also limit the direct generalizability of the results to education systems that are less open. This may not be a huge problem because research coming from the United States and the United Kingdom was already overrepresented in the field (Hale et al. 2015; Suhrcke and de Paz Nieves 2011). Altogether the results from different countries paint a surprisingly similar picture of health-related selection, and it seems that the Nordic welfare system has not been able to eradicate differences in educational outcomes between adolescents with and without health problems.

8.3 CONCLUDING REMARKS

The background section of this summary included an introduction to the history of health selection research, which has been driven by a willingness to understand the socioeconomic disparities in health. There is a certain irony in the fact that the most persistent interest toward the effect of health on SEP has been shown by a field of study considering selection a competing and, occasionally, even a controversial explanation to its own findings. While economists and pediatricians have presented their alternative takes on the issue, surprisingly few social scientists have approached the socioeconomic consequences of early health problems without (either explicitly or implicitly) aiming to explain socioeconomic health disparities in adults.

Against this backdrop, it seems necessary to acknowledge the conceptual and empirical groundwork done in the socioeconomic disparities tradition, spanning over a hundred years. Some social epidemiologists may even find the results of this study instructive: if the use of specialized care data results in stronger health–schooling relationships, it could also increase the relative contribution of selection over causation to socioeconomic health disparities among adults, compared with self-reports and proxies of health status used in most previous studies (Kröger, Pakpahan, and Hoffmann 2015). Nevertheless, it is important to notice that the present study did not aim to explain socioeconomic disparities in health. In fact, it would be misleading to draw strong conclusions about the contribution of selection to disparities because none of the sub-studies measured the health status of individuals after finishing their educational career. The results show strong health-related selection to education with regard to mental disorders and certain types of somatic conditions, but, without further data, we cannot know the extent to which these health conditions are causally related to those health conditions showing socioeconomic health disparities in adults.

First and foremost, the results of the present study should be of interest to researchers involved in explaining and understanding social stratification. The results highlight early health as a significant source of variation in educational outcomes, largely ignored by previous studies in the sociology of education. Given that educational attainment forms the basis of one's occupational prospects and income development (Cairó and Cajner 2018; Psacharopoulos and Patrinos 2018), health-related differences in educational outcomes, documented by the present study, emerge as potential catalysts for the accumulation of socioeconomic adversity over the life course. As noted by some authors (Case and Paxson 2006; Palloni 2006), early health could also act as a missing link contributing to the intergenerational transmission of socioeconomic inequality. Following the perspectives of the cumulative inequality theory, the present study hypothesized parental education to moderate the impact of health problems and health problems to mediate the transmission of educational attainment. The analyses provided only partial

support for the hypotheses, but these assumptions deserve to be examined further with an even broader age span of measuring health problems.

Most importantly, the results implied that health-related selection to education operates largely independent of family background—at least when family background is defined through factors shared by biological siblings. This observation highlights a form of early inequality that is not satisfyingly represented by the intergenerational perspectives on social stratification (Breen and Jonsson 2005) or the modern approach to health disparities emphasizing the interplay of causation and selection over the life course (Hoffmann et al. 2018). It represents an instance of "bad luck" that is perhaps best captured by the concept of *health shock*, occasionally featured in previous literature: not necessarily random with regard to genetic background, but random with regard to social origin.

The idea that involuntary, "ascribed" characteristics, such as gender, ethnicity, or parental social class, should not constrain one's chances of pursuing education is central to sociologists studying the equality of educational opportunity (Breen and Jonsson 2005). One way to interpret the findings of this study would be to include "early health problems" as a new item in the list of ascribed characteristics that define the boundaries of equal opportunities. The influential contributions of West (1991) in the tradition of socioeconomic disparities and Jenkins (1991) in disability studies proposed something like this by drawing parallels between health-related differences in social outcomes and discrimination due to gender or ethnicity. In fact, these authors appeared to consider an interpretation based on discrimination a prerequisite for social scientists to be interested in the social consequences of health problems: along the same lines as West (1991) promoted a shift away from "an asocial genetic model" of selection toward an interpretation based on stigma and discrimination, Jenkins (1991) based his argument on the socially constructed aspects of disability, emphasizing that not all disability is "natural" or "inevitable."

These statements should be understood against the contexts in which they were originally presented: heated debates on the causes of health disparities in the former and the primacy of class-oriented stratification theories in the latter. As such, they can be lauded for highlighting the potential of institutions, such as schools and workplaces, in shaping the harmful impact of health problems. Nevertheless, when the disadvantage that children with health problems experience is predefined as socially constructed, there is a risk of ignoring the biological basis of health conditions and impairments. To provide a stable ground for supporting the educational careers of all children with health problems, it should not matter whether the experienced disadvantage is ultimately biological or social in origin. In other words, the motives of studying health-related selection to education should be separated from the empirically testable causes of selection.

A similar critique has been presented previously in connection to the social model of disability, which makes a clear distinction between (biological)

impairments and socially constructed disabilities. Although the social model has been important in empowering the disability rights movement and shifting the fault away from the disabled individuals to society, it risks forgetting the real pain involved in many health conditions (Shakespeare and Watson 2001). In education policy, there is an equal risk of ignoring meaningful individual differences when health selection is conceptualized solely as a manifestation of modifiable environmental and institutional barriers and discrimination. If the economic system remains otherwise the same, it seems unlikely that any amount of "barrier removal" is enough to open equal educational opportunities and similar education-related career options for individuals undergoing a psychosis or four-limb paralysis (Shakespeare and Watson 2001; Terzi 2004). Accordingly, health problems do not compare well with social class and ethnicity, which are much more evidently social creations (Anastasiou and Kauffman 2013).

For these reasons, framing health-related selection to education as a question of justice may require more than what is provided by the language of equal opportunities or discrimination alone. Following Terzi (2005) and Vehmas (2010), a fruitful solution could be found in the capability approach, which was originally developed by Amartya Sen and Martha Nussbaum (Nussbaum 2000; Sen 2009). The capability approach maintains that *capabilities* are the most essential component in evaluating equality. They are defined as real freedoms to choose among and achieve valued *functionings*, such as reading, being well nourished and pursuing education (Terzi 2005). Thus, the fundamental question for the capability approach is "what people are actually able to be and to do" (Nussbaum 2000:40).

When the disabilities caused by health problems are understood as restrictions to valuable functionings, they begin to narrow individual capabilities and therefore enter the realm of justice (Terzi 2005). When equality is not assessed based on material resources but rather on the capacity of a person to utilize available commodities, acknowledging human diversity becomes essential in all social arrangements, such as when organizing educational institutions (Vehmas 2010). Correspondingly, the false dichotomy between the individual and social dimensions disappears with the capability approach, and it no longer matters whether the origin of the disadvantage caused by health problems is biological or social (Terzi 2005; Vehmas 2010). As emphasized by Nussbaum (2000:74), "the ultimate political goal is always the promotion of the capabilities of *each person*."

When it comes to supporting the schooling of adolescents with health problems, the results of the present study include three useful take-home messages. First, mental disorders in early adolescence are clearly the most urgent targets for prevention: regardless of family background, they pose the greatest educational risk for an individual and also explain a notable part of educational dropout at the population level. Even if the observed associations are not completely causal, mental disorders identify the share of adolescents that are especially likely to encounter problems in their educational career.

Second, school performance, as measured by grades, should not be used as the sole indicator of how adolescents with health problems fare at school. Although the other explanatory mechanisms remain unknown to the present study, it seems likely—based on previous evidence—that the negative social responses and low expectations of significant others play a salient role. Finally, the results demonstrate that adolescents experiencing mental disorders or certain somatic conditions have a lower likelihood of attaining a tertiary degree even if they manage to attain a secondary degree. However, the explanatory power of upper-secondary track choice in these findings underscores the utmost salience of upper-secondary transitions.

REFERENCES

Aarnoudse-Moens, Cornelieke Sandrine Hanan, Nynke Weisglas-Kuperus, Johannes Bernard van Goudoever, and Jaap Oosterlaan. 2009. "Meta-Analysis of Neurobehavioral Outcomes in Very Preterm and/or Very Low Birth Weight Children." *Pediatrics* 124(2):717–28.

Adams, Peter, Michael D. Hurd, Daniel McFadden, Angela Merrill, and Tiago Ribeiro. 2003. "Healthy, Wealthy, and Wise? Tests for Direct Causal Paths between Health and Socioeconomic Status." *Journal of Econometrics* 112(1):3–56.

Aizer, Anna and Janet Currie. 2014. "The Intergenerational Transmission of Inequality: Maternal Disadvantage and Health at Birth." *Science* 344(6186):856–61.

Almond, Douglas. 2006. "Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population." *Journal of Political Economy* 114(4):672–712.

Almond, Douglas, Lena Edlund, and Mårten Palme. 2009. "Chernobyl's Subclinical Legacy: Prenatal Exposure to Radioactive Fallout and School Outcomes in Sweden*." *The Quarterly Journal of Economics* 124(4):1729–72.

Anastasiou, Dimitris and James M. Kauffman. 2013. "The Social Model of Disability: Dichotomy between Impairment and Disability." *The Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine* 38(4):441–59.

Anderson, Daniel M., Kimberly M. Rennie, Richard S. Ziegler, Joseph P. Neglia, Leslie R. Robison, and James G. Gurney. 2001. "Medical and Neurocognitive Late Effects among Survivors of Childhood Central Nervous System Tumors." *Cancer* 92(10):2709–19.

Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. 2016. *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis*. 189. Paris.

Atladottir, Hjördis O., David Gyllenberg, Amanda Langridge, Sven Sandin, Stefan N. Hansen, Helen Leonard, Mika Gissler, Abraham Reichenberg, Diana E. Schendel, Jenny Bourke, Christina M. Hultman, Dorothy E. Grice, Joseph D. Buxbaum, and Erik T. Parner. 2015. "The Increasing Prevalence of Reported Diagnoses of Childhood Psychiatric Disorders: A Descriptive Multinational Comparison." *European Child & Adolescent Psychiatry* 24(2):173–83.

Barbaresi, William J., Slavica K. Katusic, Robert C. Colligan, Amy L. Weaver, and Steven J. Jacobsen. 2007. "Long-Term School Outcomes for Children with Attention-Deficit/Hyperactivity Disorder: A Population-Based Perspective." *Journal of Developmental and Behavioral Pediatrics* 28(4):265–73.

Barker, D. J. 1995. "Fetal Origins of Coronary Heart Disease." *BMJ* 311(6998):171–74.

Barre, Natalie, Angela Morgan, Lex W. Doyle, and Peter J. Anderson. 2011. "Language Abilities in Children Who Were Very Preterm and/or Very Low Birth Weight: A Meta-Analysis." *The Journal of Pediatrics* 158(5):766-774.e1.

Basch, Charles E. 2011. “Healthier Students Are Better Learners: A Missing Link in School Reforms to Close the Achievement Gap.” *Journal of School Health* 81(10):593–98.

Becker, Gary S. and Casey B. Mulligan. 1997. “The Endogenous Determination of Time Preference.” *Quarterly Journal of Economics* 112(3):729–58.

Becker, Gary S. and Nigel Tomes. 1986. “Human Capital and the Rise and Fall of Families.” *Journal of Labor Economics* 4(3, Part 2):S1–39.

Becker, Sascha O., Karolina Ekholm, and Marc-Andreas Muendler. 2013. “Offshoring and the Onshore Composition of Tasks and Skills.” *Journal of International Economics* 90(1):91–106.

Bell, Megan F., Donna M. Bayliss, Rebecca Glauert, Amanda Harrison, and Jeneva L. Ohan. 2016. “Chronic Illness and Developmental Vulnerability at School Entry.” *Pediatrics* 137(5):e20152475.

Berg, A. T., C. B. Baca, K. Rychlik, B. G. Vickrey, R. Caplan, F. M. Testa, and S. R. Levy. 2016. “Determinants of Social Outcomes in Adults with Childhood-Onset Epilepsy.” *Pediatrics* 137(4).

Bernstein, Ira M., Joan A. Mongeon, Gary J. Badger, Laura Solomon, Sarah H. Heil, and Stephen T. Higgins. 2005. “Maternal Smoking and Its Association With Birth Weight.” *Obstetrics & Gynecology* 106(5 Part 1).

Bhutta, Adnan T., Mario A. Cleves, Patrick H. Casey, Mary M. Cradock, and Karthika J. S. Anand. 2002. “Cognitive and Behavioral Outcomes of School-Aged Children Who Were Born Preterm: A Meta-Analysis.” *Journal of the American Medical Association* 288(6):728–37.

Bijlsma, Maarten J., Ben Wilson, Lasse Tarkiainen, Mikko Myrskylä, and Pekka Martikainen. 2019. “The Impact of Unemployment on Antidepressant Purchasing: Adjusting for Unobserved Time-Constant Confounding in the g-Formula.” *Epidemiology* 30(3):388–95.

Blane, David, George Davey Smith, and Mel Bartley. 1993. “Social Selection: What Does It Contribute to Social Class Differences in Health?” *Sociology of Health & Illness* 15(1):1–15.

Blane, David, George Davey Smith, and Carole Hart. 2007. “Some Social and Physical Correlates of Intergenerational Social Mobility: Evidence from the West of Scotland Collaborative Study.” *Sociology* 33(1):169–83.

Bogg, Tim and Brent W. Roberts. 2004. “Conscientiousness and Health-Related Behaviors: A Meta-Analysis of the Leading Behavioral Contributors to Mortality.” *Psychological Bulletin* 130(6):887–919.

Boman, Krister K., Frank Lindblad, and Anders Hjern. 2010. “Long-Term Outcomes of Childhood Cancer Survivors in Sweden: A Population-Based Study of Education, Employment, and Income.” *Cancer* 116(5):1385–91.

Boudon, Raymond. 1974. *Education, Opportunity, and Social Inequality*. New York: Wiley.

Brands, Augustina M. A., Geert Jan Biessels, Edward H. F. de Haan, L. Jaap Kappelle, and Roy P. C. Kessels. 2005. “The Effects of Type 1 Diabetes on Cognitive Performance.” *Diabetes Care* 28(3):726–735.

Breen, Richard and Jan O. Jonsson. 2000. “Analyzing Educational Careers: A Multinomial Transition Model.” *American Sociological Review* 65(5):754–72.

Breen, Richard and Jan O. Jonsson. 2005. “Inequality of Opportunity in Comparative Perspective: Recent Research on Educational Attainment and Social Mobility.” *Annual Review of Sociology* 31(1):223–43.

Brekke, Idunn. 2015. “Health and Educational Success in Adolescents: A Longitudinal Study.” *BMC Public Health* 15:619.

Brenner, Philip S. and John D. DeLamater. 2014. "Social Desirability Bias in Self-Reports of Physical Activity: Is an Exercise Identity the Culprit?" *Social Indicators Research* 117(2):489–504.

Breslau, Joshua, Michael Lane, Nancy Sampson, and Ronald C. Kessler. 2008. "Mental Disorders and Subsequent Educational Attainment in a US National Sample." *Journal of Psychiatric Research* 42(9):708–16.

Breslau, Joshua, Elizabeth Miller, W. J. Joanie Chung, and Julie B. Schweitzer. 2011. "Childhood and Adolescent Onset Psychiatric Disorders, Substance Use, and Failure to Graduate High School on Time." *Journal of Psychiatric Research* 45(3):295–301.

Bukodi, Erzsébet and John H. Goldthorpe. 2016. "Educational Attainment - Relative or Absolute - as a Mediator of Intergenerational Class Mobility in Britain." *Research in Social Stratification and Mobility* 43:5–15.

Cairó, Isabel and Tomaz Cajner. 2018. "Human Capital and Unemployment Dynamics: Why More Educated Workers Enjoy Greater Employment Stability." *Economic Journal* 128(609):652–82.

Campbell, David E. 2009. "Civic Engagement and Education: An Empirical Test of the Sorting Model." *American Journal of Political Science* 53(4):771–86.

Cardano, Mario, Giuseppe Costa, and Moreno Demaria. 2004. "Social Mobility and Health in the Turin Longitudinal Study." *Social Science & Medicine* 58(8):1563–74.

Carvalho, Leandro. 2012. "Childhood Circumstances and the Intergenerational Transmission of Socioeconomic Status." *Demography* 49(3):913–38.

Case, Anne, Darren Lubotsky, and Christina Paxson. 2002. "Economic Status and Health in Childhood: The Origins of the Gradient." *American Economic Review* 92(5):1308–34.

Case, Anne and Christina Paxson. 2010. "Causes and Consequences of Early Life Health." *Demography* 47(Supplement):S65–85.

Case, Anne and Christina H. Paxson. 2006. "Children's Health and Social Mobility." *The Future of Children* 16(2):151–73.

Cernerud, Lars. 1995. "Height and Social Mobility: A Study of the Height of 10 Year Olds in Relation to Socio-Economic Background and Type of Formal Schooling." *Scandinavian Journal of Public Health* 23(1):28–31.

Champaloux, Steven W. and Deborah R. Young. 2015. "Childhood Chronic Health Conditions and Educational Attainment: A Social Ecological Approach." *Journal of Adolescent Health* 56(1):98–105.

Charles, Maria and Karen Bradley. 2002. "Equal but Separate? A Cross-National Study of Sex Segregation in Higher Education." *American Sociological Review* 67(4):573–99.

Chatzitheochari, Stella and Lucinda Platt. 2019. "Disability Differentials in Educational Attainment in England: Primary and Secondary Effects." *The British Journal of Sociology* 70(2):502–25.

Van Cleave, Jeanne, Steven L. Gortmaker, and James M. Perrin. 2010. "Dynamics of Obesity and Chronic Health Conditions Among Children and Youth." *JAMA* 303(7):623–30.

Compas, Bruce E., Sarah S. Jaser, Madeleine J. Dunn, and Erin M. Rodriguez. 2012. "Coping with Chronic Illness in Childhood and Adolescence." *Annual Review of Clinical Psychology* 8(1):455–80.

Contini, Dalit, Federica Cugnata, and Andrea Scagni. 2018. “Social Selection in Higher Education. Enrolment, Dropout and Timely Degree Attainment in Italy.” *Higher Education* 75(5):785–808.

Craig, Lyn. 2006. “Parental Education, Time in Paid Work and Time with Children: An Australian Time-Diary Analysis.” *British Journal of Sociology* 57(4):553–75.

Crosnoe, Robert. 2007. “Gender, Obesity, and Education.” *Sociology of Education* 80(3):241–60.

Crump, Casey, Diana Rivera, Rebecca London, Melinda Landau, Bill Erlendson, and Eunice Rodriguez. 2013. “Chronic Health Conditions and School Performance among Children and Youth.” *Annals of Epidemiology* 23(4):179–84.

Currie, Janet. 2009. “Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development.” *Journal of Economic Literature* 47(1):87–122.

Currie, Janet. 2011. “Inequality at Birth: Some Causes and Consequences.” *American Economic Review* 101(3):1–22.

Currie, Janet, Mark Stabile, Phongsack Manivong, and Leslie L. Roos. 2010. “Child Health and Young Adult Outcomes.” *Journal of Human Resources* 45(3):517–48.

Dahl, Ronald E., Nicholas B. Allen, Linda Wilbrecht, and Ahna Ballonoff Suleiman. 2018. “Importance of Investing in Adolescence from a Developmental Science Perspective.” *Nature* 554(7693):441–50.

Dahlquist, G. and B. Källén. 2007. “School Performance in Children with Type 1 Diabetes-a Population-Based Register Study.” *Diabetologia* 50(5):957–64.

Deary, Ian J., Alison Pattie, and John M. Starr. 2013. “The Stability of Intelligence From Age 11 to Age 90 Years: The Lothian Birth Cohort of 1921.” *Psychological Science* 24(12):2361–68.

Deaton, Angus S. and Christina H. Paxson. 1998. “Aging and Inequality in Income and Health.” *The American Economic Review* 88(2):248–53.

Department of Health and Social Security. 1980. *Inequalities in Health: Report of a Research Working Group*. London.

Ding, Weili, Steven F. Lehrer, J. Niel. Rosenquist, and Janet Audrain-McGovern. 2009. “The Impact of Poor Health on Academic Performance: New Evidence Using Genetic Markers.” *Journal of Health Economics* 28(3):578–97.

Edgerton, Jason D., Lance W. Roberts, and Susanne von Below. 2011. “Education and Quality of Life.” Pp. 265–96 in *Handbook of Social Indicators and Quality of Life Research*, edited by K. Land, A. Michalos, and M. Sirgy. Dordrecht: Springer.

Eide, Eric R. and Mark H. Showalter. 2011. “Estimating the Relation between Health and Education: What Do We Know and What Do We Need to Know?” *Economics of Education Review* 30(5):778–91.

Elo, Irma T. 2009. “Social Class Differentials in Health and Mortality: Patterns and Explanations in Comparative Perspective.” *Annual Review of Sociology* 35:553–72.

Emerson, Natacha D., Brian Distelberg, Holly E. R. Morrell, Jackie Williams-Reade, Daniel Tapanes, and Susanne Montgomery. 2015. “Quality of Life and School Absenteeism in Children With Chronic Illness.” *The Journal of School Nursing* 32(4):258–66.

Erikson, Robert and Frida Rudolphi. 2010. "Change in Social Selection to Upper Secondary School - Primary and Secondary Effects in Sweden." *European Sociological Review* 26(3):291–305.

Esch, Pascale, Valéry Bocquet, Charles Pull, Sophie Couffignal, Torsten Lehnert, Marc Graas, Laurence Fond-Harmant, and Marc Ansseau. 2014. "The Downward Spiral of Mental Disorders and Educational Attainment: A Systematic Review on Early School Leaving." *BMC Psychiatry* 14(237).

Evensen, Miriam. 2019. "Adolescent Mental Health Problems, Behaviour Penalties, and Distributional Variation in Educational Achievement." *European Sociological Review* 35(4):474–490.

Evensen, Miriam, Torkild Hovde Lyngstad, Ole Melkevik, and Arnstein Mykletun. 2016. "The Role of Internalizing and Externalizing Problems in Adolescence for Adult Educational Attainment: Evidence from Sibling Comparisons Using Data from the Young HUNT Study." *European Sociological Review* 32(5):552–66.

Ferguson, Stewart C., Annette Blane, Joanna Wardlaw, Brian M. Frier, Petros Perros, Rory J. McCrimmon, and Ian J. Deary. 2005. "Influence of an Early-Onset Age of Type 1 Diabetes on Cerebral Structure and Cognitive Function." *Diabetes Care* 28(6):1431–37.

Fergusson, David M. and Lianne J. Woodward. 2002. "Mental Health, Educational, and Social Role Outcomes of Adolescents with Depression." *Archives of General Psychiatry* 59(3):225–31.

Ferraro, Kenneth F. and Tetyana Pylypiv Shippee. 2009. "Aging and Cumulative Inequality: How Does Inequality Get under the Skin?" *Gerontologist* 49(3):333–343.

Feudtner, Chris, James A. Feinstein, Wenjun Zhong, Matt Hall, and Dingwei Dai. 2014. "Pediatric Complex Chronic Conditions Classification System Version 2: Updated for ICD-10 and Complex Medical Technology Dependence and Transplantation." *BMC Pediatrics* 14(199).

Finnish National Agency for Education. 2020a. "Recognition of the Level of a Foreign Higher Education Degree." Retrieved (https://www.oph.fi/en/services/recognition-level-foreign-higher-education-degree).

Finnish National Agency for Education. 2020b. "Vipunen. Education Statistics Finland." Retrieved (https://vipunen.fi/en-gb/).

Fletcher, Jason M. 2010. "Adolescent Depression and Educational Attainment: Results Using Sibling Fixed Effects." *Health Economics* 19(7):855–71.

Fletcher, Jason M. 2011. "The Medium Term Schooling and Health Effects of Low Birth Weight: Evidence from Siblings." *Economics of Education Review* 30(3):517–27.

Fletcher, Jason M. and Michael R. Richards. 2012. "Diabetes's 'health Shock' to Schooling and Earnings: Increased Dropout Rates and Lower Wages and Employment in Young Adults." *Health Affairs* 31(1):27–34.

Fletcher, Jason M. and Barbara Wolfe. 2008. "Child Mental Health and Human Capital Accumulation: The Case of ADHD Revisited." *Journal of Health Economics* 27(3):794–800.

Flouri, Eirini. 2007. "Early Family Environments May Moderate Prediction of Low Educational Attainment in Adulthood: The Cases of Childhood Hyperactivity and Authoritarian Parenting." *Educational Psychology* 27(6):737–51.

Forgeron, Paula, Sara King, Jessica Reszel, and Karine Fournier. 2018. "Psychosocial Interventions to Improve Social Functioning of Children and

Adolescents with Chronic Physical Conditions: A Systematic Review." *Children's Health Care* 47(3):326–55.

Forrest, Christopher B., Katherine B. Bevans, Anne W. Riley, Richard Crespo, and Thomas A. Louis. 2013. "Health and School Outcomes during Children's Transition into Adolescence." *Journal of Adolescent Health* 52(2):186–94.

Foster, Helen E., Nicola Marshall, Andrea Myers, Pippa Dunkley, and Ian D. Griffiths. 2003. "Outcome in Adults with Juvenile Idiopathic Arthritis: A Quality of Life Study." *Arthritis & Rheumatism* 48(3):767–75.

Fox, A. J. and P. F. Collier. 1976. "Low Mortality Rates in Industrial Cohort Studies Due to Selection for Work and Survival in the Industry." *British Journal of Preventive and Social Medicine* 30:225–30.

Fried, Ronna, Carter Petty, Stephen V. Faraone, Laran L. Hyder, Helen Day, and Joseph Biederman. 2016. "Is ADHD a Risk Factor for High School Dropout? A Controlled Study." *Journal of Attention Disorders* 20(5):383–89.

Frisell, Thomas. 2020. "Sibling Comparison Designs, Are They Worth the Effort?" *American Journal of Epidemiology* kwaa183.

Frisell, Thomas, Sara Öberg, Ralf Kuja-Halkola, and Arvid Sjölander. 2012. "Sibling Comparison Designs: Bias from Non-Shared Confounders and Measurement Error." *Epidemiology* 23(5):713—720.

Frissen, Aleida, Ritsaert Lieverse, Machteld Marcelis, Marjan Drukker, and Philippe Delespaul. 2015. "Psychotic Disorder and Educational Achievement: A Family-Based Analysis." *Social Psychiatry and Psychiatric Epidemiology* 50(10):1511–18.

Fuchs, Victor R. 1980. "Time Preference and Health: An Exploratory Study." *National Bureau of Economic Research Working Paper Series* No. 539.

Gaudieri, Patricia A., Rusan Chen, Tammy F. Greer, and Clarissa S. Holmes. 2008. "Cognitive Function in Children With Type 1 Diabetes." *Diabetes Care* 31(9):1892–97.

Gerber, Theodore P. and Sin Yi Cheung. 2008. "Horizontal Stratification in Postsecondary Education: Forms, Explanations, and Implications." *Annual Review of Sociology* 34(1):299–318.

Ghaderi, Sara, Anders Engeland, Maria Winther Gunnes, Dag Moster, Ellen Ruud, Astri Syse, Finn Wesenberg, and Tone Bjørge. 2016. "Educational Attainment among Long-Term Survivors of Cancer in Childhood and Adolescence: A Norwegian Population-Based Cohort Study." *Journal of Cancer Survivorship* 10(1):87–95.

Goering, Sara. 2015. "Rethinking Disability: The Social Model of Disability and Chronic Disease." *Current Reviews in Musculoskeletal Medicine* 8(2):134–38.

Goffman, Erving. 1986. *Stigma: Notes on the Management of Spoiled Identity*. New York: Simon & Schuster.

Gottfredson, Linda S. 2004. "Intelligence: Is It the Epidemiologists' Elusive 'Fundamental Cause' of Social Class Inequalities in Health?" *Journal of Personality and Social Psychology* 86(1):174–99.

Goulding, Sandra M., Victoria H. Chien, and Michael T. Compton. 2010. "Prevalence and Correlates of School Drop-out Prior to Initial Treatment of Nonaffective Psychosis: Further Evidence Suggesting a Need for Supported Education." *Schizophrenia Research* 116(2–3):228–33.

Grootenhuis, M. A., H. M. Koopman, E. G. H. Verrips, A. G. C. Vogels, and B. F. Last. 2007. "Health-Related Quality of Life Problems of Children Aged

8–11 Years with a Chronic Disease." *Developmental Neurorehabilitation* 10(1):27–33.

Guryan, Jonathan, Erik Hurst, and Melissa Kearney. 2008. "Parental Education and Parental Time with Children." *Journal of Economic Perspectives* 22(3):23–46.

Gyllenberg, David, Mikko Marttila, Reijo Sund, Elina Jokiranta-Olkoniemi, André Sourander, Mika Gissler, and Tiina Ristikari. 2018. "Temporal Changes in the Incidence of Treated Psychiatric and Neurodevelopmental Disorders during Adolescence: An Analysis of Two National Finnish Birth Cohorts." *The Lancet. Psychiatry* 5(3):227–36.

Ha, Eun-Hee, Yun-Chul Hong, Bo-Eun Lee, Bock-Hi Woo, Joel Schwartz, and David C. Christiani. 2001. "Is Air Pollution a Risk Factor for Low Birth Weight in Seoul?" *Epidemiology* 12(6):643–48.

Haas, Steven A. 2006. "Health Selection and the Process of Social Stratification: The Effect of Childhood Health on Socioeconomic Attainment." *Journal of Health and Social Behavior* 47(4):339–54.

Haas, Steven A. and Nathan Edward Fosse. 2008. "Health and the Educational Attainment of Adolescents: Evidence from the NLSY97." *Journal of Health and Social Behavior* 49(2):178–92.

Hagger, Martin S. 2014. "The Multiple Pathways by Which Trait Self-Control Predicts Health Behavior." *Annals of Behavioral Medicine* 48(2):282–83.

Hale, Daniel R., Leonardo Bevilacqua, and Russell M. Viner. 2015. "Adolescent Health and Adult Education and Employment: A Systematic Review." *Pediatrics* 136(1):128–40.

Hale, Daniel R. and Russell M. Viner. 2018. "How Adolescent Health Influences Education and Employment: Investigating Longitudinal Associations and Mechanisms." *Journal of Epidemiology and Community Health* 72(6):465–70.

Halfon, Neal and Paul W. Newacheck. 2010. "Evolving Notions of Childhood Chronic Illness." *JAMA* 303(7):665–66.

Härkönen, Juho, Hande Kaymakçalan, Pirjo Mäki, and Anja Taanila. 2012. "Prenatal Health, Educational Attainment, and Intergenerational Inequality: The Northern Finland Birth Cohort 1966 Study." *Demography* 49(2):525–52.

Van Heesch, Mirjam M. J., Hans Bosma, Tanja Traag, and Ferdy Otten. 2012. "Hospital Admissions and School Dropout: A Retrospective Cohort Study of the 'Selection Hypothesis.'" *European Journal of Public Health* 22(4):550–55.

Van Der Heide, Iris, Ulrike Gehring, Gerard H. Koppelman, and Alet H. Wijga. 2016. "Health-Related Factors Associated with Discrepancies between Children's Potential and Attained Secondary School Level: A Longitudinal Study." *PLoS ONE* 11(12):e0168110.

Hermann, Bruce and Michael Seidenberg. 2007. "Epilepsy and Cognition." *Epilepsy Currents* 7(1):1–6.

Hertz, Tom, Tamara Jayasundera, Patrizio Piraino, Sibel Selcuk, Nicole Smith, and Alina Verashchagina. 2007. "The Inheritance of Educational Inequality: International Comparisons and Fifty-Year Trends." *The B.E. Journal of Economic Analysis & Policy* 7(2).

von Hippel, Paul T. and Jamie L. Lynch. 2014. "Why Are Educated Adults Slim—Causation or Selection?" *Social Science & Medicine* 105:131–39.

Hoffmann, Rasmus, Hannes Kröger, and Eduwin Pakpahan. 2018. "Pathways between Socioeconomic Status and Health: Does Health Selection or Social

Causation Dominate in Europe?" *Advances in Life Course Research* 36:23–36.

Horstmanshof, Louise. and Craig. Zimitat. 2007. "Future Time Orientation Predicts Academic Engagement among First-Year University Students." *British Journal of Educational Psychology* 77(3):703–18.

Hout, Michael. 2012. "Social and Economic Returns to College Education in the United States." *Annual Review of Sociology* 38(1):379–400.

Houtrow, Amy J., Kandyce Larson, Lynn M. Olson, Paul W. Newacheck, and Neal Halfon. 2014. "Changing Trends of Childhood Disability, 2001-2011." *Pediatrics* 134(3):530–38.

Hsin, Amy. 2012. "Is Biology Destiny? Birth Weight and Differential Parental Treatment." *Demography* 49(4):1385–1405.

Idler, Ellen L. and Yael Benyamini. 1997. "Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies." *Journal of Health and Social Behavior* 38(1):21–37.

Illsley, R. 1955. "Social Class Selection and Class Differences in Relation to Stillbirths and Infant Deaths." *British Medical Journal* 2(4955):1520–24.

Isohanni, Irene, Peter B. Jones, Marjo-Riitta Jarvelin, Pentti Nieminen, Paula Rantakallio, Jari Jokelainen, Tim J. Croudace, and Matti Isohanni. 2001. "Educational Consequences of Mental Disorders Treated in Hospital. A 31-Year Follow-up of the Northern Finland 1966 Birth Cohort." *Psychological Medicine* 31(2):339–49.

Jackson, Margot. 2009. "Understanding Links Between Adolescent Health and Educational Attainment." *Demography* 46(4):671–94.

Jackson, Margot. 2015. "Cumulative Inequality in Child Health and Academic Achievement." *Journal of Health and Social Behavior* 56(2):262–80.

Jackson, Michelle, Robert Erikson, John H. Goldthorpe, and Meir Yaish. 2007. "Primary and Secondary Effects in Class Differentials in Educational Attainment: The Transition to A-Level Courses in England and Wales." *Acta Sociologica* 50(3):211–29.

Jelenkovic, Aline, Janne Mikkonen, Pekka Martikainen, Antti Latvala, Yoshie Yokoyama, Reijo Sund, Eero Vuoksimaa, Esther Rebato, Joohon Sung, Jina Kim, Jooyeon Lee, Sooji Lee, Maria A. Stazi, Corrado Fagnani, Sonia Brescianini, Catherine A. Derom, Robert F. Vlietinck, Ruth J. F. Loos, Robert F. Krueger, Matt McGue, Shandell Pahlen, Tracy L. Nelson, Keith E. Whitfield, Ingunn Brandt, Thomas S. Nilsen, Jennifer R. Harris, Tessa L. Cutler, John L. Hopper, Adam D. Tarnoki, David L. Tarnoki, Thorkild I. A. Sørensen, Jaakko Kaprio, and Karri Silventoinen. 2018. "Association between Birth Weight and Educational Attainment: An Individual-Based Pooled Analysis of Nine Twin Cohorts." *Journal of Epidemiology and Community Health* 72(9):832–37.

Jenkins, R. 1991. "Disability and Social Stratification." *The British Journal of Sociology* 42(4):557—580.

Johnson, Jeffrey G., Patricia Cohen, Bruce P. Dohrenwend, Bruce G. Link, and Judith S. Brook. 1999. "A Longitudinal Investigation of Social Causation and Social Selection Processes Involved in the Association between Socioeconomic Status and Psychiatric Disorders." *Journal of Abnormal Psychology* 108(3):490–99.

Johnson, Monica Kirkpatrick, Robert Crosnoe, and Glen H. Elder Jr. 2011. "Insights on Adolescence From a Life Course Perspective." *Journal of Research on Adolescence* 21(1):273–80.

Johnson, Sheri L., Carol A. Winett, Björn Meyer, William J. Greenhouse, and Ivan Miller. 1999. "Social Support and the Course of Bipolar Disorder." *Journal of Abnormal Psychology* 108(4):558–66.

Kemptner, Daniel, Hendrik Jürges, and Steffen Reinhold. 2011. "Changes in Compulsory Schooling and the Causal Effect of Education on Health: Evidence from Germany." *Journal of Health Economics* 30(2):340–54.

Kessler, Roland C., Cindy L. Foster, William B. Saunders, and Paul E. Stang. 1995. "Social Consequences of Psychiatric Disorders, I: Educational Attainment." *The American Journal of Psychiatry* 152(7):1026–32.

Koch, S. V, A. M. T. Kejs, G. Engholm, C. Johansen, and K. Schmiegelow. 2004. "Educational Attainment among Survivors of Childhood Cancer: A Population-Based Cohort Study in Denmark." *British Journal of Cancer* 91(5):923–28.

Kranke, Derrick, Jerry Floersch, Lisa Townsend, and Michelle Munson. 2010. "Stigma Experience among Adolescents Taking Psychiatric Medication." *Children and Youth Services Review* 32(4):496–505.

Kröger, Hannes, Eduwin Pakpahan, and Rasmus Hoffmann. 2015. "What Causes Health Inequality? A Systematic Review on the Relative Importance of Social Causation and Health Selection." *European Journal of Public Health* 25(6):951–60.

Kuehni, Claudia E., Marie-Pierre F. Strippoli, Corina S. Rueegg, Cornelia E. Rebholz, Eva Bergstraesser, Michael Grotzer, Nicolas X. von der Weid, and Gisela Michel. 2012. "Educational Achievement in Swiss Childhood Cancer Survivors Compared with the General Population." *Cancer* 118(5):1439–49.

Kuh, D., Y. Ben-Shlomo, J. Lynch, J. Hallqvist, and C. Power. 2003. "Life Course Epidemiology." *Journal of Epidemiology and Community Health* 57(10):778–83.

Låftman, Sara B. and Charlotta Magnusson. 2017. "Do Health Complaints in Adolescence Negatively Predict the Chance of Entering Tertiary Education in Young Adulthood?" *Scandinavian Journal of Public Health* 45(8):878–85.

Lancashire, Emma R., Clare Frobisher, Raoul C. Reulen, David L. Winter, Adam Glaser, and Michael M. Hawkins. 2010. "Educational Attainment among Adult Survivors of Childhood Cancer in Great Britain: A Population-Based Cohort Study." *Journal of the National Cancer Institute* 102(4):254–70.

Lantto, Marjo, Marjo Renko, and Matti Uhari. 2008. "Trends in Childhood Mortality from 1969 to 2004 in Finland." *Acta Paediatrica* 97(8):1024–29.

Latner, J. D., K. S. O'Brien, L. E. Durso, L. A. Brinkman, and T. MacDonald. 2008. "Weighing Obesity Stigma: The Relative Strength of Different Forms of Bias." *International Journal of Obesity* 32(7):1145–52.

Layte, Richard and Cathal McCrory. 2013. "Paediatric Chronic Illness and Educational Failure: The Role of Emotional and Behavioural Problems." *Social Psychiatry and Psychiatric Epidemiology* 48(8):1307–16.

Lê, Félice, Ana Diez Roux, and Hal Morgenstern. 2013. "Effects of Child and Adolescent Health on Educational Progress." *Social Science & Medicine* 76:57–66.

van der Lee, Johanna H., Lidwine B. Mokkink, Martha A. Grootenhuis, Hugo S. Heymans, and Martin Offringa. 2007. "Definitions and Measurement of Chronic Health Conditions in Childhood: A Systematic Review." *JAMA* 297(24):2741–51.

Link, Bruce G., Francis T. Cullen, Elmer Struening, Patrick E. Shrout, and Bruce P. Dohrenwend. 1989. "A Modified Labeling Theory Approach to Mental Disorders: An Empirical Assessment." *American Sociological Review* 54(3):400–423.

Liptak, Gregory S. and Pasquale J. Accardo. 2004. "Health and Social Outcomes of Children with Cerebral Palsy." *The Journal of Pediatrics* 145(2, Supplement):S36–41.

Lloyd, C. E., N. Robinson, and J. H. Fuller. 1992. "Education and Employment Experiences in Young Adults with Type 1 Diabetes Mellitus." *Diabetic Medicine* 9(7):661–66.

Lundborg, Petter, Anton Nilsson, and Dan Olof Rooth. 2014. "Parental Education and Offspring Outcomes: Evidence from the Swedish Compulsory School Reform." *American Economic Journal: Applied Economics* 6(1):253–78.

Lynch, Jamie L. and Paul T. von Hippel. 2016. "An Education Gradient in Health, a Health Gradient in Education, or a Confounded Gradient in Both?" *Social Science & Medicine* 154:18–27.

Manor, Orly, Sharon Matthews, and Chris Power. 2003. "Health Selection: The Role of Inter- and Intra-Generational Mobility on Social Inequalities in Health." *Social Science and Medicine* 57(11):2217–27.

Mare, Robert D. 1980. "Social Background and School Continuation Decisions." *Journal of the American Statistical Association* 75(370):295–305.

Maslow, Gary R., Abigail Haydon, Annie Laurie McRee, Carol A. Ford, and Carolyn T. Halpern. 2011. "Growing up with a Chronic Illness: Social Success, Educational/Vocational Distress." *Journal of Adolescent Health* 49(2):206–12.

Mayberry, M. K., C. Probert, E. Srivastava, J. Rhodes, and J. F. Mayberry. 1992. "Perceived Discrimination in Education and Employment by People with Crohn's Disease: A Case Control Study of Educational Achievement and Employment." *Gut* 33(3):312–14.

Maynard, Brandy R., Christopher P. Salas-Wright, and Michael G. Vaughn. 2015. "High School Dropouts in Emerging Adulthood: Substance Use, Mental Health Problems, and Crime." *Community Mental Health Journal* 51(3):289–99.

Mazurek, J. M., P. L. Schleiff, and P. K. Henneberger. 2012. "Is Childhood Asthma Associated With Educational Level and Longest-Held Occupation?" *American Journal of Epidemiology* 175(4):279–88.

McAdams, Tom A., Jenae M. Neiderhiser, Fruhling V. Rijsdijk, Jurgita Narusyte, Paul Lichtenstein, and Thalia C. Eley. 2014. "Accounting for Genetic and Environmental Confounds in Associations between Parent and Child Characteristics: A Systematic Review of Children-of-Twins Studies." *Psychological Bulletin* 140(4):1138–73.

McDougall, Janette, Gillian King, David J. De Wit, Linda T. Miller, Sungjin Hong, David R. Offord, John Laporta, and Katherine Meyer. 2004. "Chronic Physical Health Conditions and Disability among Canadian School-Aged Children: A National Profile." *Disability and Rehabilitation* 26(1):35–45.

McLeod, Jane D. and Danielle L. Fettes. 2007. "Trajectories of Failure: The Educational Careers of Children with Mental Health Problems." *American Journal of Sociology* 113(3):653–701.

McLeod, Jane D. and Karen Kaiser. 2004. "Childhood Emotional and Behavioral Problems and Educational Attainment." *American Sociological Review* 69(5):636–58.

McLeod, Jane D., Ryotaro Uemura, and Shawna Rohrman. 2012. "Adolescent Mental Health, Behavior Problems, and Academic Achievement." *Journal of Health and Social Behavior* 53(4):482–97.

Melkevik, Ole, Wendy Nilsen, Miriam Evensen, Anne Reneflot, and Arnstein Mykletun. 2016. "Internalizing Disorders as Risk Factors for Early School Leaving: A Systematic Review." *Adolescent Research Review* 1(3):245–55.

Merikangas, Kathleen Ries, Jian Ping He, Marcy Burstein, Sonja A. Swanson, Shelli Avenevoli, Lihong Cui, Corina Benjet, Katholiki Georgiades, and Joel Swendsen. 2010. "Lifetime Prevalence of Mental Disorders in U.S. Adolescents: Results from the National Comorbidity Survey Replication-Adolescent Supplement (NCS-A)." *Journal of the American Academy of Child and Adolescent Psychiatry* 49(10):980–89.

Miech, Richard A., Avshalom Caspi, Terrie E. Moffitt, Bradley R. Entner Wright, and Phil A. Silva. 1999. "Low Socioeconomic Status and Mental Disorders: A Longitudinal Study of Selection and Causation during Young Adulthood." *American Journal of Sociology* 104(4):1096–1131.

Miller, Paul, Charles Mulvey, and Nick Martin. 2005. "Birth Weight and Schooling and Earnings: Estimates from a Sample of Twins." *Economics Letters* 86(3):387–92.

Ministry of Education and Culture. 2020. "The Finnish Education System." Retrieved (https://minedu.fi/en/education-system#Higher education).

Ministry of Social Affairs and Health. 2013. *Health Care in Finland*. Helsinki: Ministry of Social Affairs and Health.

Moonie, Sheniz A., David A. Sterling, Larry Figgs, and Mario Castro. 2006. "Asthma Status and Severity Affects Missed School Days." *Journal of School Health* 76(1):18–24.

Moses, Tally. 2010. "Being Treated Differently: Stigma Experiences with Family, Peers, and School Staff among Adolescents with Mental Health Disorders." *Social Science & Medicine* 70(7):985–93.

Needham, Belinda L. 2009. "Adolescent Depressive Symptomatology and Young Adult Educational Attainment: An Examination of Gender Differences." *Journal of Adolescent Health* 45(2):179–86.

Needham, Belinda L., Robert Crosnoe, and Chandra Muller. 2004. "Academic Failure in Secondary School: The Inter-Related Role of Health Problems and Educational Context." *Social Problems* 51(4):569–86.

Noble, Kimberly G., Suzanne M. Houston, Natalie H. Brito, Hauke Bartsch, Eric Kan, Joshua M. Kuperman, Natacha Akshoomoff, David G. Amaral, Cinnamon S. Bloss, Ondrej Libiger, Nicholas J. Schork, Sarah S. Murray, B. J. Casey, Linda Chang, Thomas M. Ernst, Jean A. Frazier, Jeffrey R. Gruen, David N. Kennedy, Peter Van Zijl, Stewart Mostofsky, Walter E. Kaufmann, Tal Kenet, Anders M. Dale, Terry L. Jernigan, and Elizabeth R. Sowell. 2015. "Family Income, Parental Education and Brain Structure in Children and Adolescents." *Nature Neuroscience* 18(5):773–778.

Novak, M., C. Ahlgren, and A. Hammarstrom. 2012. "Social and Health-Related Correlates of Intergenerational and Intragenerational Social Mobility among Swedish Men and Women." *Public Health* 126(4):349–57.

Nussbaum, Martha C. 2000. *Women and Human Development the Capabilities Approach*. Cambridge: Cambridge University Press.

OECD. 2012. *Equity and Quality in Education - Supporting Disadvantaged Students and Schools*. OECD Publishing.

OECD. 2013. *Education Policy Outlook: Finland*. Paris.

OECD. 2018. *Education at a Glance 2018: OECD Indicators*. Paris: OECD Publishing.

Oostrom, Kim J., Anneke Smeets-Schouten, Cas L. J. J. Kruitwagen, A. C. Boudewyn Peters, and Aagje Jennekens-Schinkel. 2003. "Not Only a Matter of Epilepsy: Early Problems of Cognition and Behavior in Children With 'Epilepsy Only'—A Prospective, Longitudinal, Controlled Study Starting at Diagnosis." *Pediatrics* 112(6):1338 LP – 1344.

Palloni, Alberto. 2006. "Reproducing Inequalities: Luck, Wallets, and the Enduring Effects of Childhood Health." *Demography* 43(4):587–615.

Parcel, Toby L., Mikaela J. Dufur, and Rena Cornell Zito. 2010. "Capital at Home and at School: A Review and Synthesis." *Journal of Marriage and Family* 72(4):828–46.

Parkkari, Jari, Ville M. Mattila, Seppo Niemi, and Pekka Kannus. 2020. "Fatal Childhood Injuries in Finland between 1971 and 2017." *Injury Epidemiology* 7(1):11.

Parkkari, Jari, Harri Sievänen, Seppo Niemi, Ville M. Mattila, and Pekka Kannus. 2016. "Injury Deaths in the Adolescent Population of Finland: A 43-Year Secular Trend Analysis between 1971 and 2013." *Injury Prevention* 22(4):239–46.

Patton, George C., Carolyn Coffey, Helena Romaniuk, Andrew Mackinnon, John B. Carlin, Louisa Degenhardt, Craig A. Olsson, and Paul Moran. 2014. "The Prognosis of Common Mental Disorders in Adolescents: A 14-Year Prospective Cohort Study." *The Lancet* 383(9926):1404–11.

Pekkarinen, Tuomas, Roope Uusitalo, and Sari Kerr. 2009. "School Tracking and Intergenerational Income Mobility: Evidence from the Finnish Comprehensive School Reform." *Journal of Public Economics* 93(7–8):965–73.

Perrott, G. St. J. and Selwyn D. Collins. 1935. "Relation of Sickness to Income and Income Change in 10 Surveyed Communities: Health and Depression Studies No. 1: Method of Study and General Results for Each Locality." *Public Health Reports (1896-1970)* 50(18):595–622.

Persson, Sofie, Gisela Dahlquist, Ulf-Göran Gerdtham, and Katarina Steen Carlsson. 2013. "Impact of Childhood-Onset Type 1 Diabetes on Schooling: A Population-Based Register Study." *Diabetologia* 56(6):1254–62.

Poropat, Arthur E. 2009. "A Meta-Analysis of the Five-Factor Model of Personality and Academic Performance." *Psychological Bulletin* 135(2):322—338.

Powell, Justin. 2003. "Constructing Disability and Social Inequality Early in the Life Course." *Disability Studies Quarterly* 23(2):57–75.

Power, Chris, Orly Manor, and Leah Li. 2002. "Are Inequalities in Height Underestimated by Adult Social Position? Effects of Changing Social Structure and Height Selection in a Cohort Study." *BMJ* 325(7356):131–34.

Priestley, Mark. 2001. *Disability and the Life Course: Global Perspectives*. Cambridge: Cambridge University Press.

Psacharopoulos, George and Harry Anthony Patrinos. 2018. "Returns to Investment in Education: A Decennial Review of the Global Literature." *Education Economics* 26(5):445–58.

Räikkönen, Katri, Tom Forsén, Markus Henriksson, Eero Kajantie, Kati Heinonen, Anu-Katriina Pesonen, Jukka T. Leskinen, Ilmo Laaksonen, Clive Osmond, David J. P. Barker, and Johan G. Eriksson. 2009. "Growth

Trajectories and Intellectual Abilities in Young Adulthood: The Helsinki Birth Cohort Study." *American Journal of Epidemiology* 170(4):447–55.

Reiss, Franziska. 2013. "Socioeconomic Inequalities and Mental Health Problems in Children and Adolescents: A Systematic Review." *Social Science & Medicine* 90:24–31.

De Ridder, Karin A. A., Kristine Pape, Roar Johnsen, Turid Lingaas Holmen, Steinar Westin, and Johan Håkon Bjørngaard. 2013. "Adolescent Health and High School Dropout: A Prospective Cohort Study of 9000 Norwegian Adolescents (The Young-HUNT)." *PLoS ONE* 8(9).

De Ridder, Karin A. A., Kristine Pape, Roar Johnsen, Steinar Westin, Turid Lingaas Holmen, and Johan Håkon Bjørngaard. 2012. "School Dropout: A Major Public Health Challenge: A 10-Year Prospective Study on Medical and Non-Medical Social Insurance Benefits in Young Adulthood, the Young-HUNT 1 Study (Norway)." *Journal of Epidemiology and Community Health* 66(11):995–1000.

Rockhill, B., B. Newman, and C. Weinberg. 1998. "Use and Misuse of Population Attributable Fractions." *American Journal of Public Health* 88(1):15–19.

Roeser, Robert W., Jacquelynne S. Eccles, and Karen R. Strobel. 1998. "Linking the Study of Schooling and Mental Health: Selected Issues and Empirical Illustrations at the Level of the Individual." *Educational Psychologist* 33(4):153–76.

Roos, Leslie L., Brett Hiebert, Phongsack Manivong, Jason Edgerton, Randy Walld, Leonard MacWilliam, and Janelle de Rocquigny. 2013. "What Is Most Important: Social Factors, Health Selection, and Adolescent Educational Achievement." *Social Indicators Research* 110(1):385–414.

Ross, S., D. Godden, D. McMurray, A. Douglas, D. Oldman, J. Friend, J. Legge, and G. Douglas. 1992. "Social Effects of Wheeze in Childhood: A 25 Year Follow Up." *BMJ (Clinical Research Ed.)* 305(September):545–48.

Rubin, Donald B. 2004. "Direct and Indirect Causal Effects via Potential Outcomes*." *Scandinavian Journal of Statistics* 31(2):161–70.

Sagatun, Ase, Sonja Heyerdahl, Tore Wentzel-Larsen, and Lars Lien. 2014. "Mental Health Problems in the 10th Grade and Non-Completion of Upper Secondary School: The Mediating Role of Grades in a Population-Based Longitudinal Study." *BMC Public Health* 14(1):16.

Sairaalaopetus. 2020. "Sairaalaopetuksen Yksiköt." Retrieved (http://www.sairaalaopetus.net/sairaalaopetuksen-yksikot/).

Schafer, Markus H., Kenneth F. Ferraro, and Sarah A. Mustillo. 2011. "Children of Misfortune: Early Adversity and Cumulative Inequality in Perceived Life Trajectories." *American Journal of Sociology* 116(4):1053–91.

Scheff, T. J. 1974. "The Labelling Theory of Mental Illness." *American Sociological Review* 39(3):444–452.

Schmidt, S., C. Petersen, and M. Bullinger. 2003. "Coping with Chronic Disease from the Perspective of Children and Adolescents – a Conceptual Framework and Its Implications for Participation." *Child: Care, Health and Development* 29(1):63–75.

Schofer, Evan and John W. Meyer. 2005. "The Worldwide Expansion of Higher Education in the Twentieth Century." *American Sociological Review* 70(6):898–920.

Scholtens, Sara, Ann-Margret Rydell, and Fan Yang-Wallentin. 2013. "ADHD Symptoms, Academic Achievement, Self-Perception of Academic

Competence and Future Orientation: A Longitudinal Study." *Scandinavian Journal of Psychology* 54(3):205–12.

Schultz, T. Paul. 2002. "Wage Gains Associated with Height as a Form of Health Human Capital ." *American Economic Review* 92(2):349–53.

Sen, Amartya. 2009. *The Idea of Justice*. London: Penguin.

Shakespeare, Torn and Nicholas Watson. 2001. "The Social Model of Disability: An Outdated Ideology?" Pp. 9–28 in *Exploring Theories and Expanding Methodologies: Where we are and where we need to go*. Vol. 2, *Research in Social Science and Disability*, edited by S. N. Barnartt and B. M. Altman. Emerald Group Publishing Limited.

Shandra, Carrie L. and Dennis P. Hogan. 2009. "The Educational Attainment Process Among Adolescents with Disabilities And Children of Parents with Disabilities." *International Journal of Disability, Development, and Education* 56(4):363–79.

Shifrer, Dara, Rebecca M. Callahan, and Chandra Muller. 2013. "Equity or Marginalization? The High School Course-Taking of Students Labeled with a Learning Disability." *American Educational Research Journal* 50(4):656–82.

Silventoinen, Karri, Aline Jelenkovic, Reijo Sund, Antti Latvala, Chika Honda, Fujio Inui, Rie Tomizawa, Mikio Watanabe, Norio Sakai, Esther Rebato, Andreas Busjahn, Jessica Tyler, John L. Hopper, Juan R. Ordoñana, Juan F. Sánchez-Romera, Lucia Colodro-Conde, Lucas Calais-Ferreira, Vinicius C. Oliveira, Paulo H. Ferreira, Emanuela Medda, Lorenza Nisticò, Virgilia Toccaceli, Catherine A. Derom, Robert F. Vlietinck, Ruth J. F. Loos, Sisira H. Siribaddana, Matthew Hotopf, Athula Sumathipala, Fruhling Rijsdijk, Glen E. Duncan, Dedra Buchwald, Per Tynelius, Finn Rasmussen, Qihua Tan, Dongfeng Zhang, Zengchang Pang, Patrik K. E. Magnusson, Nancy L. Pedersen, Anna K. Dahl Aslan, Amie E. Hwang, Thomas M. Mack, Robert F. Krueger, Matt McGue, Shandell Pahlen, Ingunn Brandt, Thomas S. Nilsen, Jennifer R. Harris, Nicholas G. Martin, Sarah E. Medland, Grant W. Montgomery, Gonneke Willemsen, Meike Bartels, Catharina E. M. van Beijsterveldt, Carol E. Franz, William S. Kremen, Michael J. Lyons, Judy L. Silberg, Hermine H. Maes, Christian Kandler, Tracy L. Nelson, Keith E. Whitfield, Robin P. Corley, Brooke M. Huibregtse, Margaret Gatz, David A. Butler, Adam D. Tarnoki, David L. Tarnoki, Hang A. Park, Jooyeon Lee, Soo Ji Lee, Joohon Sung, Yoshie Yokoyama, Thorkild I. A. Sørensen, Dorret I. Boomsma, and Jaakko Kaprio. 2020. "Genetic and Environmental Variation in Educational Attainment: An Individual-Based Analysis of 28 Twin Cohorts." *Scientific Reports* 10(12681).

Singh, Harminder, Zoann Nugent, Marni Brownell, Laura E. Targownik, Leslie L. Roos, and Charles N. Bernstein. 2015. "Academic Performance among Children with Inflammatory Bowel Disease: A Population-Based Study." *The Journal of Pediatrics* 166(5):1128–33.

Sjölander, Arvid, Elisabeth Dahlqwist, and Johan Zetterqvist. 2016. "A Note on the Noncollapsibility of Rate Differences and Rate Ratios." *Epidemiology* 27(3).

Sjölander, Arvid, Thomas Frisell, Ralf Kuja-Halkola, Sara Öberg, and Johan Zetterqvist. 2016. "Carryover Effects in Sibling Comparison Designs." *Epidemiology* 27(6):852–58.

Smith, J. P. 1999. "Healthy Bodies and Thick Wallets: The Dual Relation between Health and Economic Status." *The Journal of Economic Perspectives : A Journal of the American Economic Association* 13(2):144–66.

Smith, James P. 2009. "The Impact of Childhood Health on Adult Labor Market Outcomes." *The Review of Economics and Statistics* 91(3):478–89.

Sourander, A., L. Helstel, T. Ristkari, K. Ikheimo, H. Helenius, and J. Piha. 2001. "Child and Adolescent Mental Health Service Use in Finland." *Social Psychiatry and Psychiatric Epidemiology* 36(6):294–98.

Stadler, Matthias, Miriam Aust, Nicolas Becker, Christoph Niepel, and Samuel Greiff. 2016. "Choosing between What You Want Now and What You Want Most: Self-Control Explains Academic Achievement beyond Cognitive Ability." *Personality and Individual Differences* 94:168–72.

Statistics Finland. 2011. "Infant Mortality in 1936 to 2010." Retrieved (https://www.stat.fi/til/ksyyt/2010/ksyyt_2010_2011-12-16_kat_007_en.html).

Statistics Finland. 2020a. "Educational Structure of Population." Retrieved (https://www.stat.fi/til/vkour/tau_en.html).

Statistics Finland. 2020b. "Population Structure." Retrieved (http://www.stat.fi/til/vaerak/tau_en.html).

Steinberg, Laurence, Sandra Graham, Lia O'Brien, Jennifer Woolard, Elizabeth Cauffman, and Marie Banich. 2009. "Age Differences in Future Orientation and Delay Discounting." *Child Development* 80(1):28–44.

Stoep, Ann Vander, Noel S. Weiss, Elena Saldanha Kuo, Doug Cheney, and Patricia Cohen. 2003. "What Proportion of Failure to Complete Secondary School in the US Population Is Attributable to Adolescent Psychiatric Disorder?" *The Journal of Behavioral Health Services & Research* 30(1):119–24.

Suhrcke, Marc and Carmen de Paz Nieves. 2011. *The Impact of Health and Health Behaviours on Educational Outcomes in High-Income Countries: A Review of the Evidence*. Copenhagen.

Sznitman, Sharon R., Liza Reisel, and Atika Khurana. 2017. "Socioeconomic Background and High School Completion: Mediation by Health and Moderation by National Context." *Journal of Adolescence* 56:118–26.

Tackman, Allison M., Sanjay Srivastava, Jennifer H. Pfeifer, and Mirella Dapretto. 2017. "Development of Conscientiousness in Childhood and Adolescence: Typical Trajectories and Associations with Academic, Health, and Relationship Changes." *Journal of Research in Personality* 67:85–96.

Teachman, Jay. 2012. "Health Limitations and Post-Secondary School Enrollment." *Population Research and Policy Review* 31(1):85–96.

Terzi, Lorella. 2004. "The Social Model of Disability: A Philosophical Critique." *Journal of Applied Philosophy* 21(2):141–57.

Terzi, Lorella. 2005. "Beyond the Dilemma of Difference: The Capability Approach to Disability and Special Educational Needs." *Journal of Philosophy of Education* 39(3):443–59.

The Finnish Social Insurance Institution. 2020. "Existing, New and Withdrawn Entitlements to Reimbursement of Drug Expenses." Retrieved (http://raportit.kela.fi/ibi_apps/WFServlet?IBIF_ex=NIT084AL&YKIELI=E).

The National Institute for Health and Welfare. 2019. *Kouluterveyskysely 2019 (School Health Survey 2019)*. 33/2019. Helsinki.

The National Institute for Health and Welfare. 2020. "Children, Young People and Families. Children's Welfare Indicators in Finland. School and Learning." Retrieved (https://www.sotkanet.fi/sotkanet/en/index).

Uiters, Ellen, Erica Maurits, Mariël Droomers, Marieke Zwaanswijk, Robert A. Verheij, and Fons van der Lucht. 2014. "The Association between

Adolescents' Health and Disparities in School Career: A Longitudinal Cohort Study." *BMC Public Health* 14:1104.

Vågerö, Denny and Raymond Illsley. 1995. "Explaining Health Inequalities: Beyond Black and Barker: A Discussion of Some Issues Emerging in the Decade Following the Black Report." *European Sociological Review* 11(3):219–41.

VanderWeele, Tyler J. 2013. "A Three-Way Decomposition of a Total Effect into Direct, Indirect, and Interactive Effects." *Epidemiology* 24(2):224–32.

VanderWeele, Tyler J. and Mirjam J. Knol. 2014. "A Tutorial on Interaction." *Epidemiologic Methods* 3(1):33–72.

VanderWeele, Tyler J. and Eric J. Tchetgen Tchetgen. 2017. "Mediation Analysis with Time Varying Exposures and Mediators." *Journal of the Royal Statistical Society. Series B, Statistical Methodology* 79(3):917–38.

Vansteelandt, Stijn, Maarten Bekaert, and Theis Lange. 2012. "Imputation Strategies for the Estimation of Natural Direct and Indirect Effects." *Epidemiologic Methods* 1(1).

Vehmas, Simo. 2010. "Special Needs: A Philosophical Analysis." *International Journal of Inclusive Education* 14(1):87–96.

Viner, Russell M., Elizabeth M. Ozer, Simon Denny, Michael Marmot, Michael Resnick, Adesegun Fatusi, and Candace Currie. 2012. "Adolescence and the Social Determinants of Health." *Lancet* 379(9826):1641–52.

Walker, Janet S., Daniel Coleman, Junghee Lee, Peter N. Squire, and Barbara J. Friesen. 2008. "Children's Stigmatization of Childhood Depression and ADHD: Magnitude and Demographic Variation in a National Sample." *Journal of the American Academy of Child & Adolescent Psychiatry* 47(8):912–20.

Wang, Aolin and Onyebuchi A. Arah. 2015. "G-Computation Demonstration in Causal Mediation Analysis." *European Journal of Epidemiology* 30(10):1119–1127.

Warren, John Robert. 2009. "Socioeconomic Status and Health across the Life Course: A Test of the Social Causation and Health Selection Hypotheses." *Social Forces* 87(4):2125–53.

Weitzman, M., L. V Klerman, G. Lamb, J. Menary, and J. J. Alpert. 1982. "School Absence: A Problem for the Pediatrician." *Pediatrics* 69(6):739—746.

Wennick, Anne, Inger Hallström, Björn Lindgren, and Kristian Bolin. 2011. "Attained Education and Self-Assessed Health Later in Life When Diagnosed with Diabetes in Childhood: A Population-Based Study." *Pediatric Diabetes* 12(7):619–26.

West, Patrick. 1991. "Rethinking the Health Selection Explanation for Health Inequalities." *Social Science and Medicine* 32(4):373–84.

Wolke, Dieter, Andrea Waylen, Muthanna Samara, Colin Steer, Robert Goodman, Tamsin Ford, and Koen Lamberts. 2009. "Selective Drop-out in Longitudinal Studies and Non-Biased Prediction of Behaviour Disorders." *British Journal of Psychiatry* 195(3):249–56.

Yelland, Lisa N., Amy B. Salter, and Philip Ryan. 2011. "Performance of the Modified Poisson Regression Approach for Estimating Relative Risks from Clustered Prospective Data." *American Journal of Epidemiology* 174(8):984–92.

Zheng, Hui. 2017. "Why Does College Education Matter? Unveiling the Contributions of Selection Factors." *Social Science Research* 68:59–73.

Zou, G. 2004. "A Modified Poisson Regression Approach to Prospective Studies with Binary Data." *American Journal of Epidemiology* 159(7):702–6.